The role of ‘Play Touch Rugby League’ and self-paced interval running for improving men’s health

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Declaration

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Literature Review

1.0 Introduction

The aim of this review is to critique the pertinent research on: a) the role of team sports for promoting health and social well-being, and identify some of the perceived barriers associated with team sports, b) the movement and physiological demands of small-sided games (SSGs) and c) the physiological adaptations that manifest from playing SSGs.

1.1 Sport for health

The role of physical activity (PA) and sport to promote health is a topical area of interest. The majority of the literature has focused on PA, which is defined as “any bodily movement produced by skeletal muscles that results in energy expenditure” (Caspersen, Powell & Christenson, 1985, p. 126). Previous research has reported that PA can reduce the risk of non-communicable diseases, including cardiovascular disease (CVD), hypertension, type 2 diabetes mellitus (T2DM), osteoporosis, cancer as well as reducing feelings of anxiety and depression (Downward & Rasciute, 2015; Eime et al., 2014; Haskell et al., 2007). However, there is an emerging realisation that sport, defined as “a human activity involving physical exertion and skill as the primary focus, with elements of competition where rules and patterns of behaviour governing the activity exists formally through organisations” could be used to promote public health (Kahn et al., 2012).

There are, however, those who are sceptical about the use of sports to promote health, suggesting that competition and collisions could lead to poor adherence and increased injury risk (Waddington, 2000). This has resulted in public health discourse, such as the Physical Activity Guidelines in the UK Review and Recommendations (Bull, 2010), lacking reference to sport in current guidelines. The focus is instead placed upon developing lifelong participation in PA. However, small-sided games (SSGs), and particularly non-contact versions could be used to promote sport, PA and health, whilst minimising the risk of injury.

1.1.1 Participation rates in sport

Despite the well-documented health risks associated with physical inactivity, a large percentage of the population do not currently meet the recommended levels of PA (Townsend et al., 2015). Figure one shows the percentage of the UK adult population, according to the Active People Survey (Sport England; (APS) 8, 2014), that have taken part in sport between 2005/06 and 2013/14, indicating that participation rates have not changed substantially. There could be several reasons, including work and/or family commitments from youth to adulthood (Figure 2) and the negative conotations associated team sport activity. However, as non-contact SSGs such as touch rugby can reduce some of the negative effects of sport, it is plausible to suggest that further work is required to investigate the efficacy of non-contact SSGs across all populations.

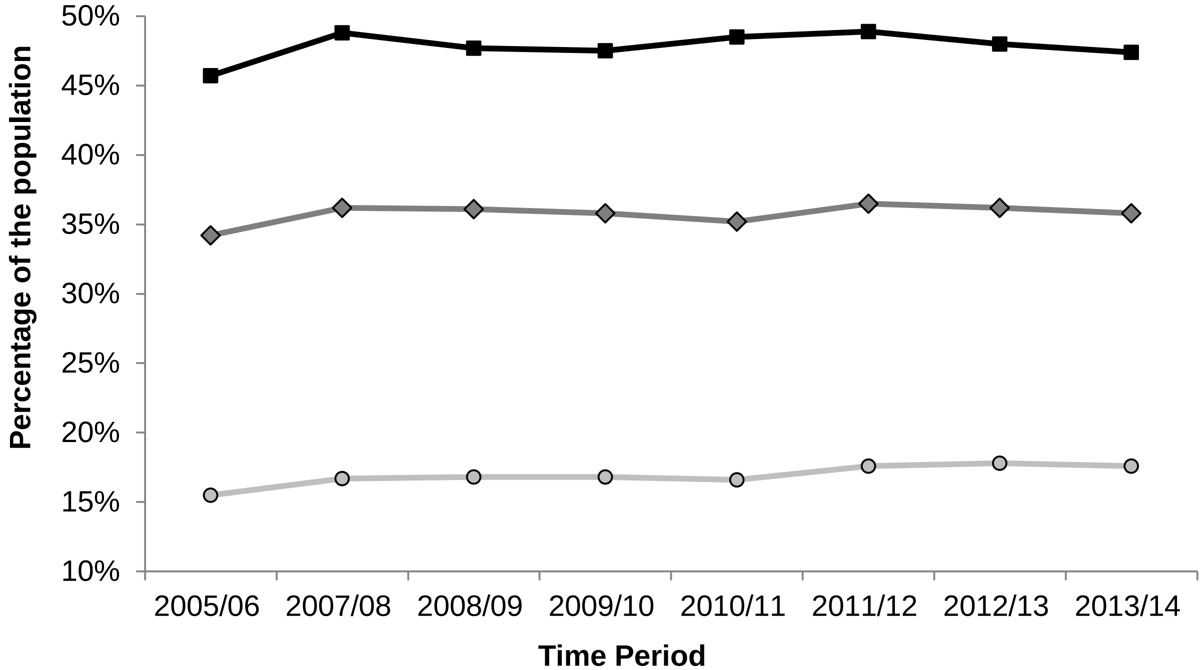

Figure 1. Percentage of the adult (> 16 years) population that have taken part in sport (black), take part at least once per week (dark grey) and take part in sport three or more times per week (light grey) (Sport England; APS8, 2014).

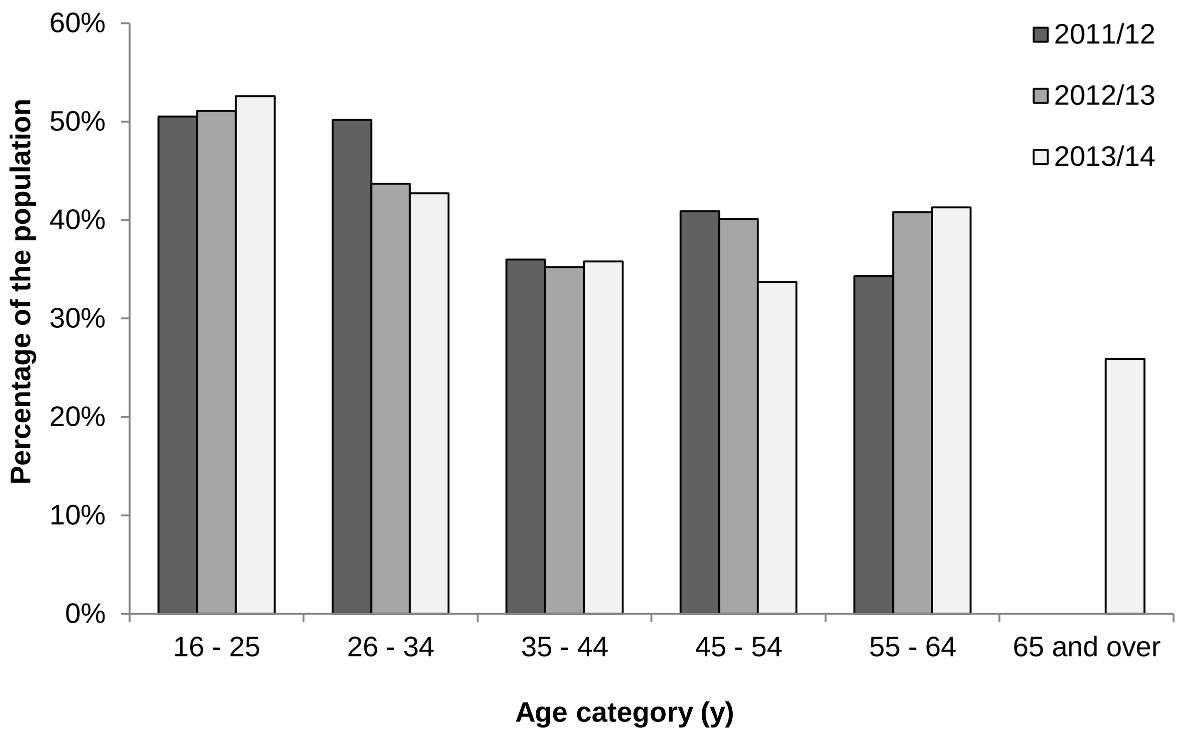

Figure 2. Percentage of the population playing organised sport in relation to age category (Sport England, APS 8, 2014).

These findings were retrieved from the APS, which has several limitations. For example, APS is based on a landline phone survey, thus excluding those without this facility (i.e. students). Further APS fails to differentiate between some physical activities and sport. Nonetheless, the data provides some evidence to suggest that SSGs, and particularly those with minimal or no contacts that are less competitive than non-modified team sports, could be used to promote sport across the age groups.

1.1.2 Are those participating in sport currently doing enough?

Although APS data suggest 36% of the UK population are taking part in sport once per week, it can be assumed that this is not sufficient to gain any significant health benefits (Eime et al., 2014c). In 2012, the British Heart Foundation reported that only 67% and 55% of all men and women in England, respectively, achieved the UK recommendations (Townsend, Wickramasinghe, Williams, Bhatnager & Rayner, 2015), suggesting many adults are not sufficiently active to gain any health benefits (Eime et al. 2013c). Hence, the addition of small-sided games (SSGs) to habitual PA could prove beneficial for populations who do not meet these recommendations (Eime et al., 2014; Berg et al., 2014). One reason SSGs might be appealing is due to the playful rather than hypercompetitive environment, allowing for diversity of personal competencies to be realised and more enjoyment found (Berg et al., 2014). Further, non-conctact versions of SSGs such as touch rugby might be better placed compared to non-modifed team sports through reducing competitiveness and injury risk.

1.2 Social benefits associated with small-sided games

1.2.1 Adherence

Nielsen et al. (2014) reported that 80% and 89% of participants who completed one of two interventions investigating the health benefits of SSGs in 65- to 75-year-old men (Schmidt et al., 2014) and men with T2DM (Schmidt et al., 2013), respectively, continued playing 12 months after the intervention. This was in contrast to the 15% of participants who continued Spinning or Crossfit classes. As both groups used by Schmidt et al. (2014) were provided with equal opportutnies and required to attend twice per week, differences in complicance were attributed to players feeling part of a team, friendships and enjoyment. As Ryan, Frederick, Lepés, Rubio and Sheldon (1997) noted, exercise adherence is closely linked to an individual’s motivation and therefore, it is reasonable to suggest that non-contact SSGs, might be suitable in motivating the participants to continue playing (Nielsen et al., 2014).

1.2.2 Enjoyment

Recently Brunn et al. (2014) reported that enjoyment was an essential quality of SSGs amongst male cancer patients. Similarly, Nielsen et al. (2014) reported that amongst middle-aged and elderly men, being part of a team, enjoyment and interacting with others encouraged some to continue playing on a regular basis. In contrast, participants who performed strength training (Schmidt et al., 2014) and running exercise (Elbe, Strahler, Krustrup & Wikman 2010) reported that there was little social interaction between players, suggesting that SSGs that provide enjoyment and social interactions, might be better placed for some populations (Nielsen et al., 2014).

1.2.3 Social capital

Social capital concerns “properties of social life, such as trust, norms and networks, which promote co-operation between participants and thereby enhance society’s efficiency” (Putnam, 1993; p. 167 as cited in Ottensen, Jeppesen & Krustrup, 2010). It has been reported that SSGs provided individual social capital (Ottensen et al., 2010) as well as a sense of positive mutual interdependency and feelings of collectively (Brunn et al., 2014). SSGs have the potential to promote social capital, through the development of trust and ‘bonding social capital’, which refers to the development of social networks between those with similar interests (i.e. teammates). Futhermore, SSGs could develop ‘bridging social capital’, referring to the development of social bonds between those with fewer ties (i.e. ‘we stories’ between work colleagues; Sport Scotland, 2013). Therefore, SSGs might be a suitable alternative for those who wish to develop social capital, whilst taking part in PA.

1.2.4 Mental health

Previous literature has reported that sports participation is associated with improved psychological health, positively affecting feelings of anxiety, stress, depression, mood, emotions and self-esteem (Mutrie & Biddle, 1995; Edwards, 2015). Sports participation can improve psychological health above that reported for other forms of PA (Eime, Young, Harvey, Charity & Payne, 2013a, 2013b). However, it is important to note that injury, overtraining, feeling of exclusion and training addiction, could negatively affect mental health. Therefore, SSGs, and particularly non-contact versions might offer an alternative that, for some populations, could reduce symptoms of mental health. To date, no research has investigated the effects of SSGs on risk factors associated with mental health suggesting further work is warranted.

1.3 Areas that can limit the usefulness of small-sided games

1.3.1 Risk of injury

Injuries can have a severe impact on participants’ lives, including their state of health, family and work commitments and financial implications. Several authors have reported high injury rates in community-level footballers (Chalmers, Samaranyaka, & McNoe, 2013), amateur footballers (Herrero, Salinero, & Del Coso, 2014) and rugby players (Junge, Cheung, Edwards, & Dvorak, 2004). There is an inherent risk of injury during sport, due to both intrinsic (height, body mass index, age, weight, playing experience, initial fitness) and extrinsic (pitch conditions, intensity, weather conditions) factors (Chalmers et al., 2013; Gabbett & Domrow, 2005). However, the injury incidence during skill-based conditioning sessions such as touch rugby has been reported to be low compared to continuous running activities (Gabbett 2002). In agreement, Oja et al. (2015) recently reported that amongst untrained populations, injury risk is low during SSGs (1 per 500h). Therefore, interventions that focus on enjoyment and skills rather than competition (Gabbett 2002), could be useful for promoting public health (Kahn et al., 2012).

1.3.2 Planning, time commitment and social exclusion

The planning and time commitments required to organise and/or participate in sport might present a potential ‘barrier’ to continued participation. As Waddington (2000) pointed out, sport cannot be played alone and must involve two or more opposing players and a high degree of cooperation. Although the large amount of organisation might limit their usefulness to promote public health for some populations, for those who enjoy the team environment, SSGs might provide an alternative form of physical activity.

Furthermore, as team sports are often played on two or more occasions per week at the same time, this could create a potential ‘barrier’, as participants might not want to commit to playing multiple times per week. Although, Nielsen et al. (2014) recently reported that the set days, times and locations were perceived as a positive attribute to their participants’ adherence, the population used consisted of elderly men (65-75 y). It is possible some participants’ might have retired and therefore the rigid, inflexible time structure might not have affected their schedule to the same extent as those with other commitments. As previous studies have used interventions lasting more than 8-weeks and required participants to play several times per week, further work is required to investigate the efficacy of a short intervention, whereby players only commit to playing once per week over a short period of time.

The team sport environment might exclude certain populations. Nielsen et al. (2014) recently reported that some participants felt it was difficult to join a team, as they felt stigmatized by virtue of their age after the intervention period. However, this finding was no different to those participating in spinning or Crossfit, whereby they also felt age would alienate them from the “youth-full” fitness culture (Nielsen et al., 2014). Therefore, SSGs such as Play Touch Rugby League (PTRL), that allows a mixture of ages (> 16 y) and genders, might provide a viable alternative.

1.3.3 Cost

Although previous research has found that the cost of sport presents a potential 'barrier' (Steenhuis, Nooy, Moes, & Schuit, 2009), SSGs are often based on 'pay-as-you-play'. For example, the average cost for PTRL is £2.50 per session (http://www.playtouchrugbyleague.co.uk). It is, therefore, reasonable to suggest that SSGs that allow 'pay-as-you-play' might be view favourably by those wishing to participate in sport, without paying membership or joining fees.

1.4 Physiological and movement demands of small-sided games

Recent work has sought to establish the physiological and movement demands of SSGs. SSGs have become a popular activity due to the numerous sport-specific actions, the ability to develop technical skills and tactical awareness, and maintain compliance and motivation (Hill-Haas, Dawson, Impellizzeri & Coutts, 2011). Several sports including handball (Iacono, Eliakim & Mechel, 2015; Buchheit et al., 2009), basketball (Conte, Favero, Niederhausen, Capranica & Tessitore, 2015), soccer (Owen, Twist & Ford; 2004; Randers, Nielsen, Bangsbo & Krustrup, 2014; Rampinini et al., 2007) and rugby (Foster, Twist, Lamb, Nicholas, 2010; Gabbett, Abernethy & Jenkins, 2012) have been adapted. Furthermore, SSGs have recently been advocated as a form of PA that can promote the health of sedentary and/or diseased populations (Krustrup et al., 2009).

1.4.1 Factors influencing the intensity of small-sided games

1.4.1.1 Pitch area

Table 1 provides a summary of the literature that has explored the impact of pitch size on the heart rate, blood lactate concentrations ([Bla^-]) and ratings of perceived exertion (RPE). Current data indicates that increasing the pitch size causes an increase in heart rate, RPE and [Bla^-] (Hill-Haas et al., 2011). For example, Rampinini et al. (2007) increased the pitch size during several SSGs games, which corresponded to an increase in heart rate, [Bla^-] and RPE. These findings suggest that an increase in the pitch area elevates the exercise intensity, potentially owing to the further distance players are required to cover (Hill-Haas et al., 2011). The [Bla^-] reported by Rampinini et al. (2007) suggests that a larger area results in more aerobic activity and a higher occurrence of activities above the lactate threshold (Tessitore, Meeusen, Piacentini, Demarie & Capranica, 2006). Only two studies have investigated the role of the pitch area on RPE, with both authors reporting a higher RPE on the large pitch compared to the small pitch (Rampinini et al., 2007; Casamichana & Castellano, 2010), suggesting distance does influence their perception of physical exertion.

In contrast, Kelly and Drust (2009) reported no difference in heart rate response when played on three pitch areas. This finding might have been influenced by the number of technical actions completed during the SSGs. For example, Kelly and Drust (2009) reported a significantly higher number of shots and tackles in the smaller pitch area, thus potentially increasing the intensity. Based on the current literature, it is difficult to conclude the impact pitch area has on the physiological responses during SSGs. Although it appears the intensity is higher on larger pitches, the influence of player standard, coach's encouragement, player number and technical actions might confound the current findings.

Table 1. Summary of the effects of pitch dimensions on SSGs intensity.

Authors	**Sport**	**Format**	**Pitch Size (m)**	**Average $\%HR_{max}$**	**[BLa$^-$] (mmol·L^{-1})**	**RPE**
Rampinini et al. (2007)	Soccer	3 vs. 3	12 x 20	87.6 ± 1.7	4.4 ± 1.1	6.6 ± 0.4
			15 x 25	88.6 ± 2.9	4.6 ± 1.0	7.0 ± 0.6
			18 x 30	89.1 ± 1.8	5.0 ± 1.5	7.2 ± 0.7
		4 vs. 4	16 x 24	86.5 ± 3.4	4.2 ± 1.6	6.3 ± 0.5
			20 x 30	86.7 ± 3.0	4.3 ± 1.4	6.6 ± 0.6
			24 x 36	87.2 ± 2.8	4.7 ± 1.2	6.8 ± 0.5
		5 vs. 5	20 x 28	86.0 ± 4.0	3.9 ± 0.9	5.9 ± 0.7
			25 x 35	86.1 ± 3.7	4.1 ± 1.4	6.2 ± 0.8
			30 x 42	86.9 ± 3.2	4,6 ± 1.7	6.2 ± 0.6
		6 vs. 6	24 x 32	83.5 ± 5.0	3.4 ± 1.0	4.8 ± 0.9
			30 x 40	85.1 ± 3.3	3.9 ± 1.4	6.0 ± 1.4
			36 x 48	85.0 ± 3.6	3.6 ± 1.5	5,9 ± 0.5
Owen et al. (2004)	Soccer	3 vs. 3	20 x 15	81.7	-	-
			25 x 20	81.8	-	-
			30 x 25	84.8	-	-
		4 vs. 4	25 x 20	72.0	-	-
			30 x 25	78.5	-	-
			35 x 30	79.5	-	-
		5 vs. 5	30 x 25	75.7	-	-
			35 x 30	79.5	-	-
			40 x 35	80.2	-	-
Kelly & Drust, (2009)		5 vs. 5	30 x 20	91.0 ± 4.0	-	-
			40 x 30	90.0 ± 4.0	-	-
			40 x 40	89.0 ± 2.0	-	-
Casamichana & Castellano, (2010).	Soccer	6 vs. 6	32 x 23	86.0 ± 5.8	-	5.7 ± 1.0
			50 x 35	88.5 ± 4.9	-	6.7 ± 0.8
			62 x 44	88.9 ± 3.9	-	6.7 ± 0.8

Data presented as mean ± standard deviation. Owen et al. (2004) presented a mean only. – indicates data not reported.

1.4.1.2 Player number

Table 2 summarises the effects of player numbers on exercise intensity, whilst keeping pitch size constant. There is a general consensus that intensity is reduced as player numbers increase. Conte et al. (2015) reported a reduction in heart rate (-2.6%) and a significantly lower RPE during the 4 versus 4 games compared to 2 versus 2, respectively. In agreement, Sampaio et al. (2007) reported a reduction in heart rate during 3 versus 3 compared 2 versus 2. Whilst Foster et al. (2010) observed a significant reduction in heart rate during 6 versus 6 compared to 4 versus 4 in the 15 to 16 age group, no difference was observed for the 12 to 13 age group. This finding is likely attributed to skill levels and spatial awareness, suggesting younger players play in a confined pitch areas, regardless of available space. Although there is scarce research investigating the effects of player number in isolation, the current findings suggest that as the number of players increases the intensity is reduced, suggesting that, for populations who might be at increased risk of injury from high intensities, the addition of players might lower any potential risk.

Table 2. Summary of the effects of play numbers on SSGs.

Authors	**Sport**	**Game format**	**Average % HRmax**	**[BLa-] (mmol·L-1)**	**RPE**
Foster et al. (2010)	Touch Rugby	4 vs. 4	90.6 ± 2.4	-	-
		6 vs. 6	86.2 ± 3.5	-	-
		4 vs. 4	88.1 ± 4.2	-	-
		6 vs. 6	89.3 ± 4.0	-	-
Conte et al. (2015)	Handball	2 vs. 2	89.9 ± 3.1	-	8.8 ± 0.9[b]
		4 vs. 4	87.3 ± 3.2	-	7.7 ± 1.1[b]
Sampaio et al (2007)	Soccer	2 vs. 2	83.7 ± 1.4	-	15.5 ± 0.6[a]
		3 vs. 3	80.8 ± 1.7	-	15.8 ± 0.2[a]

Data presented as mean ± standard deviation. [a] indicated global RPE, [b] indicated Borgs CR-10 scale. – indicates data not reported.

1.4.1.3 Coach encouragement

Coach encouragement has been suggested to increase the intensity of SSGs (Hill-Hass et al., 2011; Aguiar, Botelho, Lago, Macas & Sampaio, 2012). Rampinini et al. (2007) investigated the impact of coach encouragement on heart rate response, $[BLa^-]$ and RPE. The results indicate that, heart rate response (88.7 ± 2.8 vs. 86.5 ± 3.5 %HRmax), $[BLa^-]$ (5.5 ± 1.7 vs. 4.2 ± 1.4 mmol·L^{-1}) and RPE (7.7 ± 0.8 vs. 6.3 ± 0.9) are significantly higher with coach encouragment compared to without. In agreement, Gracia, Garcia, Canada and Ibanez (2014) reported significantly more time (68.0% vs. 40.8%) was spent above 85% of their maximum heart rate when players were provided with coach encouragement.

1.4.1.4 Rule modifications

A common rule change is the addition/removal of a goalkeeper. Dellal et al. (2008) reported a significant (12%) increase in heart rate response in 8 versus 8 with a goalkeeper compared with without (80.3 ± 12.5 vs. 71.7 ± 6.3%). This finding might suggest the presence of a goalkeeper encouraged scoring and/or defending and therefore increased the exercise intensity. A second rule change concerns the duration, work-to-rest ratio and regime (interval vs. continuous). The majority of the literature used interval-based SSGs ranging from 2 x 4 minutes to 36 x 30 seconds or work-to-rest of between 1:1 (Aroso, Rebelo & Gomes-Pereira, 2004) and 5.3:1 (Little & Williams, 2007). In contrast, several authors have used continuous regimes, for example, Hill-Haas, Rowsell, Dawson and Coutts, (2009) used 1 x 24 minutes of SSGs. It is not clear what the potential benefits of each regime has over the other and therefore further work is required. Finally, several authors have manipulated the aims of the games through the addition or removal of goals, thus changing the focus from scoring to possession, the addition of offside play and the addition of a 'floater' player, who plays for the team in possession.

1.4.2 Movement demands and energy expenditure during small-sided games

Owing to the reduced pitch size and playing time, the distances reported during SSGs are substantially less than those during traditional team sports. However, the total, low-intensity and high-intensity distance vary depending on the game format. Mallo and Navarro (2007) reported significantly less distance covered when playing 3 versus 3 with a goalkeeper, compared to 3 versus 3 with a 'floater' player. Further, as pitch size (25 x 40 m to 40 x 60 m) and playing time (40 minutes to 50 minutes) increased, the distance covered (2563 ± 259 m to 3371 ± 203 m) was increased (Mendham et al., 2014). Additionally, accelerations and decelerations (> 1.5 $m \cdot s^{-1}$) during SSGs have been reported to be high during all formats, but higher during the 3 versus 3 (500 ± 139 m) compared to 5 versus 5 (459 ± 143 m) and 7 versus 7 (396 ± 144 m) (Randers et al., 2014).

Energy expenditure during PA is a key factor in promoting health (Krustrup et al., 2013). Therefore, it is important to understand energy expenditure in relation to the demands of SSGs. Toh, Guelfi, Wong and Fournier (2011) reported players expended 0.3 to 0.4 $kJ \cdot kg^{-1} \cdot min^{-1}$ during 30 minutes of SSGs. However, this estimate was based on treadmill running and therefore fails to account for the energy costs of sports-specific movements. Gaudino, Alberti & Iaia (2014) observed slightly higher values of between 0.7 and 0.8 $kJ \cdot kg^{-1} \cdot min^{-1}$ using the method outlined by Di Prampero et al. (2005). However, this only represented a 4-minute standardised period and was not representative of the whole session. Further, the validity and reliability of this method have recently been questioned, with the authors reporting GPS derived metabolic power is 'likely' to 'largely' underestimate total energy expenditure due to several factors (Buchheit, Manouvier, Cassiram, & Morin, 2015). Firstly, the calculation used is based on speed and therefore does not measure energy expenditure during recovery or rest periods. Secondly, the equation is based on maximal sprint acceleration, which might not be replicated during SSGs. Finally, the equation used is not player specific and fails to account for individual differences in running economy (Buchheit et al., 2015). Notwithstanding this, the authors reported a moderate reliability for session average metabolic power.

1.5 Adaptations associated with participation in small-sided games

1.5.1 Body composition

Obesity and being overweight is associated with elevated risks of several non-communicable diseases, making this the fifth leading cause of death (Maessen et al., 2014). Obesity is projected to rise over the next two decades, resulting in approximately 11-million adults in the United Kingdom being obese by 2030 (Wang, McPherson, Marsh, Gortmaker & Brown, 2011). The prevalence of obesity is also an economic concern, with an additional £5.5 billion required by the National Health Service by 2050 (Wang et al., 2011). Accordingly, the World Health Organization has placed a large emphasis on lowering the prevalence of obesity (James, 2008).

Increasing PA using SSGs could contribute to improving health through positive changes in body composition (Krustrup & Bangsbo, 2015). Table 3 summarises the current literature exploring the effects of SSGs on body composition. There is a general consensus that between eight and twenty-four weeks can lower total body mass, percentage body fat (%BF) and fat mass (FM). Further, almost all studies reported a positive increase in fat free mass (FFM) of between 0.5 and 5.9%. In contrast, Fillau et al. (2015) reported no change in total body mass and %BF after 12-weeks of touch rugby training. However, Fillau et al. (2015) used 4-site skinfolds to determine changes in %BF. This method requires the use of an equation that estimates %BF which might not have detected small, but worthwhile changes. In addition, the authors used males and females, but did not analyse these separately and therefore, changes might have been observed in one sex but not the other. Although the majority of the literature reported a reduction in total body mass, Seabra et al. (2014) reported a significant increase in total body mass after 20-weeks in overweight boys. This finding might be explained by the increase in FFM (~5%), due to either the training intervention or maturation.

To date, limited work has explored changes in body composition in relation to the physiological, movement and energetic demands of SSGs. Accordingly, high intensity SSGs might provide an opportunity to increase energy expenditure and improve energy balance and body composition (Hill, Wyatt, & Peters, 2012). Table 3 indicates that intervention periods ranged from eight to sixty-four weeks, with participants attending between one and three sessions per week. However, it has been noted that one of the most frequent perceived ‘barriers’ to taking in PA is lack of time (Biddle & Batterham, 2015). The shortest intervention period used was eight weeks, albeit compliance rates ranged from 7.1 to 7.4 sessions (Mendham et al., 2014b). Further, data provided by the Rugby Football League suggest that participants attended an average of 5.3 PTRL sessions out of 10 (unpublished data; Rugby Football League). It is currently unknown if shorter interventions (< 8-weeks) of SSGs can improve measures of body composition.

Table 3. Percentage change in a range of body compositional measures after a period of SSGs.

Author	Population	Format	Weeks	Body mass	Fat mass	Percentage body fat	Lean Body Mass	Waist: hip ratio	BMI (kg·m^2)
Filliau et al. (2015)	Sedentary male and females		12	0% ↔	-	0% ↔	-	-	-
Andersen et al. (2014)	Men with T2DM		12	0.8% ↓	3.7% ↓*	3.3% ↓*	0.8% ↑	-	-
			24	1.2% ↓	5.8% ↓*	4.9% ↓*	1.1% ↑	-	-
Krustrup et al. (2009)	Untrained men		12	1.3% ↓*	13.6%↓*	11.7% ↓*	2.9% ↑*	-	1.2% ↓*
Barene et al. (2013)	Untrained females		12	2.0% ↓*	4.5% ↓*	6.9% ↓*	0.9% ↑	2.2%↓	-
Mendham et al. (2014a)	Inactive men		12	1.4% ↓	-	-	-	2% ↓*	14.2% ↓*
Mendham et al. (2014b)	Sedentary middle-aged men		8	0.2% ↓	2.9% ↓*	3.7 % ↓*	1.9 % ↑*	1.1% ↓	0% ↔
Knoepfli-Lenzin et al. (2010)	Active men with hypertension		12	2.0% ↓*	8.6% ↓*	6.9% ↓*	1.0% ↑	2.2% ↓	-
Krustrup et al. (2013)	Untrained hypertensive men		12	-	4.1% ↓	4.2% ↓	0.5% ↑	-	-
			24	-	6.7% ↓	7.2% ↓	0.4% ↑	-	-
Krustrup et al. (2010b)	Premenopausal women		16	1.4% ↑*	6.1% ↓	6.7% ↓*	3.9% ↑*	-	1.2% ↑
			64	0.8% ↓*	4.8% ↓	4.9% ↓	2.1% ↑*	-	1.2% ↓

Mohr et al. (2014)	Sedentary, hypertensive, premenopausal women	15	1.8% ↓	6.3% ↓*	2.1%↓*	2.8% ↑*	-	-
Randers et al. (2010)	Untrained males	12	1.7% ↓	12.1% ↓*	8.9% ↓*	2.0% ↑	-	-
		64	1.8% ↓	16.1% ↓*	16.1% ↓*	4.3% ↑*	-	-
Randers et al. (2012)	Homeless men	12	1.0% ↓	12.1% ↓*	9.8% ↓*	2.0% ↑*		1.3% ↓
Seabra et al. (2014)	Overweight boys	20	5.4% ↑*	-	2.4% ↓	5.0% ↑*	-	1.3% ↑
De Sousa et al. (2014)	T2DM men and women	12	4.2% ↓*	11.1% ↓*	6.9% ↓	0.3% ↓	-	4.3% ↓*
Mendham et al. (2015)	Men	8	0.2% ↓	2.9% ↓*	3.7% ↓*	1.9% ↑*	1.1% ↓	0.0% ↔
Vasconcellos et al. (2015)	Obese adolescents	12	5.4% ↓*	-	4.9% ↓*	5.9% ↑	6.6% ↓	2.3% ↓*

Data presented as the percentage changed from 0 weeks. ↑ = increase, ↓ = decrease, ↔ = no change. * denotes significantly different from baseline (*P* < 0.05). – Data not reported.

1.5.2 Blood Pressure

Hypertension is defined as a systolic blood pressure (SBP) ≥140 mmHg and/or diastolic blood pressure (DBP) ≥90 mmHg. Furthermore, physical inactivity and low fitness are associated with the development of hypertension (Pescatello et al., 2004) and an increased the risk of developing CVD, stroke, coronary heart disease and heart failure (Pescatello et al., 2004; Whelton, Chin, Xin & He, 2002).

SSGs appear to more beneficial for reducing blood pressure in normotensive and hypertensive populations (Table 4) compared to other training modalities (Krustrup, Dvorak, Junge & Bangsbo, 2010c). For example, Krustrup et al. (2009) compared the effects of soccer-specific SSGs and running on blood pressure, reporting that SSGs was more effective at lowering systolic (-3 mmHg vs. +3 mmHg) but not diastolic blood (-1 mmHg vs. -2 mmHg) pressure after 4-weeks. After 12 weeks, the SSGs and running group appeared as effective for lowering SBP (-8 mmHg vs. -8 mmHg, respectively) and DPB (-5 mmHg vs. -5mmHg, respectively). Potential mechanisms have been attributed to lower arterial stiffness (Krustrup et al. 2013), myocardial systolic and diastolic function (Schmidt et al., 2013), and reduced vascular resistance (Krustrup et al., 2009).

Although current data suggest SSGs are effective, focus has been placed largely on inactive and/or diseased populations. It is, therefore, unknown if the addition of SSGs can provide further benefits in already active populations. To date, only one study has explored the effects of SSGs on blood pressure over a short duration (Krustrup et al., 2009). As shorter interventions are likely to be popular and attended for the full duration, further research is warranted to reinforce the findings.

Table 4. Changes in systolic, diastolic blood pressure and resting heart rate after a period of SSGs.

Author	Duration (min)	Sessions per week	Weeks	Population	SBP (mmHg)	DBP (mmHg)	Resting Heart rate ($b \cdot min^{-1}$)
Krustrup et al. (2009)	60	2-3	4	Untrained men	2.0 ↓	1.0 ↓	3.0 ↓
			12		8.0 ↓*	5.0 ↓*	6.0 ↓*
Barene et al. (2013)	60	2-3	12	Women	2.2 ↑	0.8 ↑	-
Mendham et al. (2014a)	45	2-3	12	Inactive men	0.3 ↓	1.5 ↓	-
Andersen et al. (2010a)	60	2	12	Untrained hypertensive men	12.3 ↓*	7.0 ↓*	12.0 ↓*
Barene et al. (2014)	60	1.5 – 2.4	40	Women	0.3 ↓	0.8 ↓	-
Krustrup et al. (2013)	60	2	24	Hypertensive men	13.0 ↓*	8.0 ↓*	8.0 ↓*
Krustrup et al. (2014)	60	3	10	9-10 year old boys	1.0 ↓	0.8 ↓	0.5 ↓
Krustrup et al. (2010)	60	2-3	16	Premenopausal women	3.0 ↓	3.0 ↓	4.0 ↓*
			64		3.0 ↓	3.0 ↓	7.0 ↓*
Mohr et al. (2014)	60	3	15	Premenopausal hypertensive women	12.0 ↓*	6.0 ↓*	8.0 ↓*
Randers et al. (2012)	60	2.8	12	Homeless men	0.0 ↔	2.0 ↓	4.0 ↓*
Schmidt et al. (2013)	60	2	12	Diabetic men	9.0 ↓*	7.0 ↓*	6.0 ↓*
			24		9.0 ↓*	8.0 ↓*	8.0 ↓*
Filliau et al. (2014)	90	1	12	Sedentary men and women	19 ↓*	7.5 ↓*	4.8 ↓*

Data presented as absolute change from baseline. ↑ = increase. ↓ = decrease, ↔ = no change. *denotes significantly change from baseline (*P* < 0.05)

1.5.3 Resting heart rate

An elevated resting heart rate (RHR) (>75 b·min^{-1}) is associated with higher %BF, hypertension and high cholesterol, triglycerides, glucose and insulin (Fox et al., 2007), and has been linked to several non-communicable diseases (Arnold, Fitchett, Howlett, Lonn & Tardif, 2008). Therefore, PA interventions that can lower RHR effectively could prove beneficial for improving public health.

Table 4 provides a summary of the current literature that has explored the effects of SSGs on RHR. The results indicate a dose-response relationship between length of intervention and the magnitude of the reduction in RHR. For example, Schmidt et al. (2013) reported reductions of 6 b·min^{-1} and 8 b·min^{-1} after 12 and 24 weeks, respectively. Similarly, Krustrup et al. (2009) reported a reduction of 3 and 6 b·min^{-1} after 4 and 12 weeks, respectively. It has been postulated that two-to-three sessions of SSGs over a 12-week period could reduce sympathetic outflow and systemic vascular resistance (Krustrup et al. 2009). Furthermore, elevations in blood volume and ventricular volume, as well as peripheral adaptations, including increased muscle capillarisation, oxidative enzyme activity and mitochondrial density/volume (Krustrup et al., 2010a, 2009) could also elicit reductions in RHR.

Current research that has investigated the benefits of SSGs for lowering RHR has focused on untrained or diseased populations. However, it is unknown if the addition of SSGs to an already active lifestyle can still bring about reductions in RHR. Previous research has utilised two-to-three sessions per week over a 10- to 16-week period. It is reasonable to suggest those who take part in SSGs are unlikely to commit to two-to-three session per week, but might commit to once per week and over a longer period of time. Filliau et al. (2014) reported a significant reduction after one session per week for 12-weeks. Therefore, further work is required to reinforce these findings and to explore whether SSGs provide any benefit over other training modalities.

1.5.4 Inflammation

Inflammation is an immunological function that is upregulated during the presence of harmful stimuli (You, Arsenis, Disanzon, & LaMotte, 2013). However, if the acute response is not properly ‘phased out’, this response can develop into chronic low-grade inflammation, which has been linked to atherosclerosis, CHD, hypertension, metabolic syndrome, some cancers, T2DM and several neurodegenerative disorders (Mendham, Donges, Luberts & Duffield, 2011; Petersen & Pedersen, 2005). Two key markers of low-grade systemic inflammation are Interleukin 6 (IL-6) and C-reactive protein (CRP). IL-6 production by preadipocytes, fibroblasts, monocytes and macrophages is more pronounced in those that are overweight or obese, which in turn can increase the induction of hepatic CRP (Bastard et al., 2006).

SSGs could reduce the concentrations of circulating pro-inflammatory cytokines, through several mechanisms. One mechanism might include lowering FM and %BF. Mendham et al. (2014b) reported a significant reduction in FM (23.8 ± 6.0 vs. 23.1 ± 6.1) and %BF (27.2 ± 2.9 vs. 26.2 ± 3.3), which coincided with a significant reduction in IL-6 (2.05 ± vs. 1.35 ± 0.43 pg·mL^{-1}) and CRP (2.90 ± 0.59 vs. 2.45 ± 0.59 mg·L^{-1}) after only 8-weeks of touch rugby. In support, Donges et al. (2013) reported significant reductions in %BF after 12-weeks of endurance (2.8 ± 1.2%) and resistance (2.9 ± 1.0%) training, which was accompanied by a significant reduction in concentrations of IL-6. In contrast, Mendham et al. (2014a) found significant reductions in BMI and WC, but no significant change in IL-6 or CRP concentrations after 12-weeks of SSGs in inactive men. However, this finding might be explained by the use of an Indigenous population, who presented risk factors associated with T2DM. Moreover, Donges, Duffield and Drinkwater (2010) found a significant reduction in CRP after 10-weeks of resistance training compared to no change in the endurance (continuous cycling at 70-75% HRmax) group, suggesting that mechanical loading during the resistance training was important to promote FFM and lower CRP concentrations.

Recently, high-intensity interval training has been proposed a potentially useful form of PA to promote public health (Biddle & Batterham, 2015), and has been reported to reduced levels of circulating IL-6 and CRP after only two weeks (3 sessions per week), in recreationally active men and women (Hovanloo, Arefirad & Ahmadizad, 2013). Therefore, it is plausible to suggest that short interventions (<8 weeks) of SSGs, could also lower concentrations of circulating inflammatory cytokines.

1.6 Conclusion

In conclusion, SSGs could provide an ideal environment to promote PA and reduce the risk of non-communicable diseases. Additionally, this environment could improve adherence to exercise, enjoyment and social capital, which has potential to reduce anxiety, stress, depression and subsequently improve mental health. Majority of the research has focused on inactive and/or disease populations and therefore the impact of SSGs in active populations is unknown. Finally, improvements in health have been observed after a short period of SSGs (i.e. 8 weeks). However, as commitment and time has been referred to as a potential ‘barrier’, further research exploring the efficacy of short SSGs interventions to promote health in warranted.

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The role of ‘Play Touch Rugby League’ and self-paced interval running for improving men’s health

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Abstract

Over recent years, the use of team sports for health promotion has become a topical area of interest. Previous research has investigated the impact of small-sided games (SSGs) on cardiovascular, metabolic and musculoskeletal fitness, body composition, chronic systemic inflammation, enjoyment, social capital and adherence. However, research has primarily focused on inactive and/or diseased populations using interventions ranging from 8- to 40-weeks. With 'time' often being perceived as a 'barrier' to sports participation, prolonged interventions, like those typically used, might not appropriate to promote public health. Therefore, the aim of this study was to assess the impact of 4-weeks of Play Touch Rugby League (PTRL) and self-paced interval running (RUN) on several health markers within an active population. Sixteen men were recruited into a PTRL *(n* = 8) or RUN (*n* = 8) group and completed four consecutive weeks of PTRL or RUN. Health markers (resting heart rate (RHR), systolic (SBP) and diastolic (DBP) blood pressure, body mass, fat mass (FM), percentage body fat (%BF), fat free mass (FFM), waist circumference (WC), hip circumference (HC), waist-to-hip ration (WHR), body mass index (BMI), stress and inflammatory markers) were measured before and after the intervention period. During each session, participants wore a global positioning system (GPS) and heart rate monitor to record the internal and external demands of each session. The external demands varied between interventions, with the RUN group covering a larger total, low intensity and moderate intensity distance at a higher average velocity compared to the PTRL group. In contrast, the PTRL covered more high intensity distance and achieved a greater maximum velocity. After 4-weeks of PTRL and RUN, RHR, SBP and FM were *likely* lower. In contrast, only the PTRL group reported a lower %BF and higher FFM after 4-weeks. WC and HC were *possibly*

lower after the RUN intervention but were *likely* and *possibly* higher at the PTRL intervention. Changes in C-reactive protein (CRP) were *unclear* after 4-weeks of RUN and PTRL, but interleukin-6 (IL-6) concentration was *very likely* lower in the PTRL group. Between groups differences for positive well-being, psychological distress and fatigue were *unclear,* but session RPE (sRPE) was *likely* lower during the PTRL intervention. In conclusion, 4-weeks of PTRL or RUN performed once per week, in addition to habitual physical activity, was sufficient to improve several markers of health in an active male population.

Declaration

This work is original and not been previously submitted in support of a Degree qualification or other courses.

Signed ……………………………………………

Date: 12th October 2015

Contents

List of figures and tables

Introduction

Physical inactivity has been suggested to increase the prevalence of non-communicable diseases, including CVD, hypertension, T2DM, osteoporosis and increase the risk of stress and depression (Downward & Rasciute, 2015; Eime et al., 2014; Haskell et al., 2007). Regular physical activity (PA) has been advocated as an important prevention strategy against the development of disease (Mendham, Duffield, Marino & Coutts, 2014b, 2015), as well as cutting the economic (Berg et al., 2014) and social (Durstine et al., 2012) costs.

To date, the majority of literature has focused on continuous aerobic-based training, such as walking, jogging or cycling (Mendham et al., 2015), with the assumption these can be developed during youth and maintained throughout adulthood (Berg et al., 2014). However, a recent report by the British Heart Foundation (Townsend, Wickramasinghe, Williams, Bhatnager & Rayner, 2015) stated that amongst adults, only ~67% of men and ~55% of women in England met the Physical Activity Guidelines in the UK Review and Recommendations (Bull, 2010). Further, amongst those taking part in PA, many are not sufficiently active to gain any significant health benefits (Eime et al., 2013c). Consequently, emphasis should be placed on promoting PA and/or sport in active populations in addition to those who are sedentary, obese/overweight and/or at risk of disease.

Small-sided games (SSGs) have recently been proposed as a potential long-term health promoting activity (Krustrup et al., 2010a; 2010c; Krustrup & Bangsbo, 2015), which could promote enjoyment (Brunn et al., 2014; Nielsen et al., 2014), social capital (Ottensen et al., 2010) and exercise adherence (Schmidt et al., 2013, 2014), above that of continuous aerobic-based training (Elbe et al., 2010). Furthermore, it is possible SSGs could be used to encourage advances in mental well-being through reductions in anxiety, stress and depression, which might be influenced by the encouragement, support, enjoyment and friendships found during SSGs (Eime, Young, Harvey, Charity & Payne, 2013a, 2013b).

SSGs are high-intensity intermittent team sports that require players to perform multiple accelerations, decelerations and sport-specific actions. Due to these demands, it has been proposed that SSGs could be used to elicit positive adaptations on markers of health (body composition, blood pressure, resting heart rate (RHR), glucose regulation, insulin sensitivity, aerobic fitness, capillary density, low-grade systemic inflammation), which are either greater than, or comparable to other training modalities (Krustrup et al., 2009). Although SSGs could result in injury due to the lack of control over the intensity and possible collisions (Waddington, 2000), Gabbett et al. (2002) reported a lower prevalence of injuries during rugby-specific SSGs, compared to continuous running activities. In agreement, Oja et al. (2015) recently reported that amongst untrained populations, injury risk was low during SSGs (1 per 500h), thus supporting the use of SSGs for promoting public health (Kahn et al., 2012).

Several studies have reported reductions in blood pressure and RHR after between four and sixty-four weeks of SSGs in untrained, overweight and/or diseased populations (Krustrup et al., 2009, 2010a, 2013; Mendham., 2014a, 2014b; Barene et al., 2013, 2014; Randers et al., 2012; Schmidt et al., 2014; Mohr et al., 2014). Furthermore, it appears there is a dose-response relationship between length of intervention (i.e. weeks) and the magnitude of change in blood pressure and RHR. For example, Krustrup et al. (2009) reported a reduction of 2.0 mmHg and 1.0 mmHg in SBP and DBP after 4-weeks, compared to a reduction of 8.0 mmHg and 5.0 mmHg after 12-weeks, respectively. Similarly, a non-significant reduction in RHR was observed after 4-weeks (3 b·min^{-1}), but a significant reduction was reported after 12-weeks (6 b·min^{-1}; Krustrup et al., 2009). It has been proposed that reductions in arterial stiffness and vascular resistance and elevations in blood volume, ventricular volume, muscle capillarization, oxidative enzyme activity, mitochondrial density and mitochondrial volume could all contribute to reductions in blood pressure and RHR, after a period of SSGs (Krustrup et al., 2009, 2010a).

Studies which have used SSGs to promote health, have consistently reported positive changes in body composition (Krustrup et al., 2010a). Current literature indicates that SSGs are effective at improving body composition, through eliciting reductions in body mass, FM and %BF (Krustrup et al., 2010a). For example, several authors have found significant reductions in body mass of between 0.8% and 5.4% after between eight and twenty weeks (2-3 sessions per week) of SSGs (Mendham et al., 2014b; Krustrup et al., 2009, 2013; Randers et al., 2010, 2012; Morh et al., 2014; Vasconcellos et al., 2015; Andersen et al., 2014; Barene et al., 2013). This reduction is often accompanied by a significant reduction in FM and %BF, which might have important implications for reducing the prevalence of obesity. Furthermore, previous research has reported a significant increase in FFM after a period of SSGs. For example, Mendham et al. (2014b, 2015) reported a significant increase (1.9%) in FFM after only 8-weeks of rugby-specific SSGs. This has been attributed to the high-mechanical loading experienced during rapid accelerations and decelerations which might increase intracellular activity and myofibrilliar protein synthesis (Krustrup et al., 2010b).

Inflammation is a highly orchestrated immunological function that is upregulated during the presence of noxious stimuli (You, Arsenis, Disanzo & LaMonte, 2013). However, failure of the acute response to be ‘phased out’ and the adoption of unhealthy habits, including physical inactivity can result in an elevated concentration of circulating cytokines, acute phase proteins and adhesion molecules (You et al., 2013). Given that the concentration of pro-inflammatory cytokines (i.e. Interleukin-6 (IL-6), tumour-necrosis factor (TNF)-a, C-reactive protein (CRP)) and anti-inflammatory cytokines (i.e. Interleukin-10) are strongly linked to FM and FFM, physical activities that can elicit positive changes in body composition might reduce the risk of inflammatory-related diseases. Indeed, Mendham et al. (2014b) reported significant reductions in FM (2.9%) and %BF (3.7%), which coincided with a significant reduction in concentrations of IL-6 (2.05 ± vs. 1.35 ± 0.43 pg·mL$^{-1)}$ and CRP (2.90 ± 0.59 vs. 2.45 ± 0.59 mg·L^{-1}) after only eight weeks. Similarly, Donges et al. (2013) reported a significant reduction in %BF after 12-weeks of aerobic- and resistance-based training, which was accompanied by a significant reduction in IL-6 concentration. In contrast, Mendham et al. (2014a) found no change in IL-6 or CRP concentrations after 12-weeks of rugby-specific SSGs. This might be explained by the use of an Indigenous population, insufficient changes in %BF and/or changes in dietary behaviours. To date, limited work has explored the impact of SSGs on the inflammatory state, thus the usefulness of SSGs to promote reductions in pro-inflammatory remains inconclusive.

Whilst it appears SSGs are effective at promoting health, majority of the literature has focused on sedentary and/or diseased populations. However, with a large proportion of the population active, it is unknown if the addition of SSGs to already active populations could further promote health above that of other training modalities. Current literature has used intervention periods of between eight and forty-eight weeks, with participants attending between two-to-three sessions per week. However, it has been noted that ‘time’ is often referred to as a perceived 'barrier' to participation in sport and PA (Biddle & Batterham, 2015) and therefore, interventions that require a significant commitment might limit the usefulness of SSGs to promote public health. Unpublished data from the Rugby Football League (RFL) indicated that during a 10-week 'Play Touch Rugby League' season, participants (*n* = 78) attended an average of 5.4 sessions (unpublished data; Rugby Football League). Furthermore, recreational populations typically play less than twice per week (Randers et al., 2010), yet only one study has investigated the impact of SSGs when played once per week (Filliau et al., 2015). It is therefore unknown if playing once per week over a short intervention period can provide sufficient stimuli to promote health.

Therefore, the purpose of this study was to assess the training-induced changes in blood pressure, RHR, body composition, pro-inflammatory cytokines and stress after a 4-week PTRL and RUN intervention. It was hypothesised, that the PTRL intervention would increase feelings of well-being and reduce feelings of psychological distress, fatigue and perceived exertion compared to the RUN intervention. Furthermore, it is hypothesised that PTRL will promote larger reductions in %BF, FM, RHR, blood pressure and IL-6 and CRP, whilst increasing FFM above that of the RUN group.

2.0. Methods

2.1 Participants

Sixteen recreationally active men were recruited through the RFL and by convenience sampling (Table 5). Inclusion criteria were 18-50 years old, residing in the North West England and physically active over the last 6 months. Exclusion criteria included smoking, the intake of medications or drugs and diagnosis of any pre-existing cardiovascular, inflammatory or metabolic disorders. This information was ascertained prior to enrolling using a non-validated health questionnaire (Appendix 1). Ethical approval was obtained from the University of Chester's Faculty of Life Sciences Ethics Committee (Appendix 2). Each participant was provided with an outline of the study procedures (Appendix 3 & 4), before providing verbal and written informed consent (Appendix 5).

2.2 Study design

A non-randomised mixed model design was employed with participants assigned to either a PTRL (*n* = 8) or a self-paced interval running (RUN; *n* = 8) group. A sample size of 16 participants (8 per group) was calculated using G*Power (G*Power, Universität Kiel, Germany), with an alpha level of 0.05 and a power of 0.80. Effect sizes were calculated from the difference between the means divided by the pooled SD for several key dependent variables (e.g. fat mass, percentage body fat, resting blood pressure and heart rate).

The PTRL group enrolled in a touch rugby league programme for 4-weeks and the RUN group completed 4-weeks of self-paced interval running. Before and after both interventions, measurements of RHR, blood pressure, body mass, stature, body composition, stress and a fasting blood samples were taken to assess the changes in these health markers over the intervention period. During each session, the internal and external demands of PTRL and RUN were measured using a global positioning system (GPS) and heart rate monitors. Finally, at the end of each session, all participants completed a Subjective Exercise Experience Scale (SEES) and provided a rating of perceived exertion.

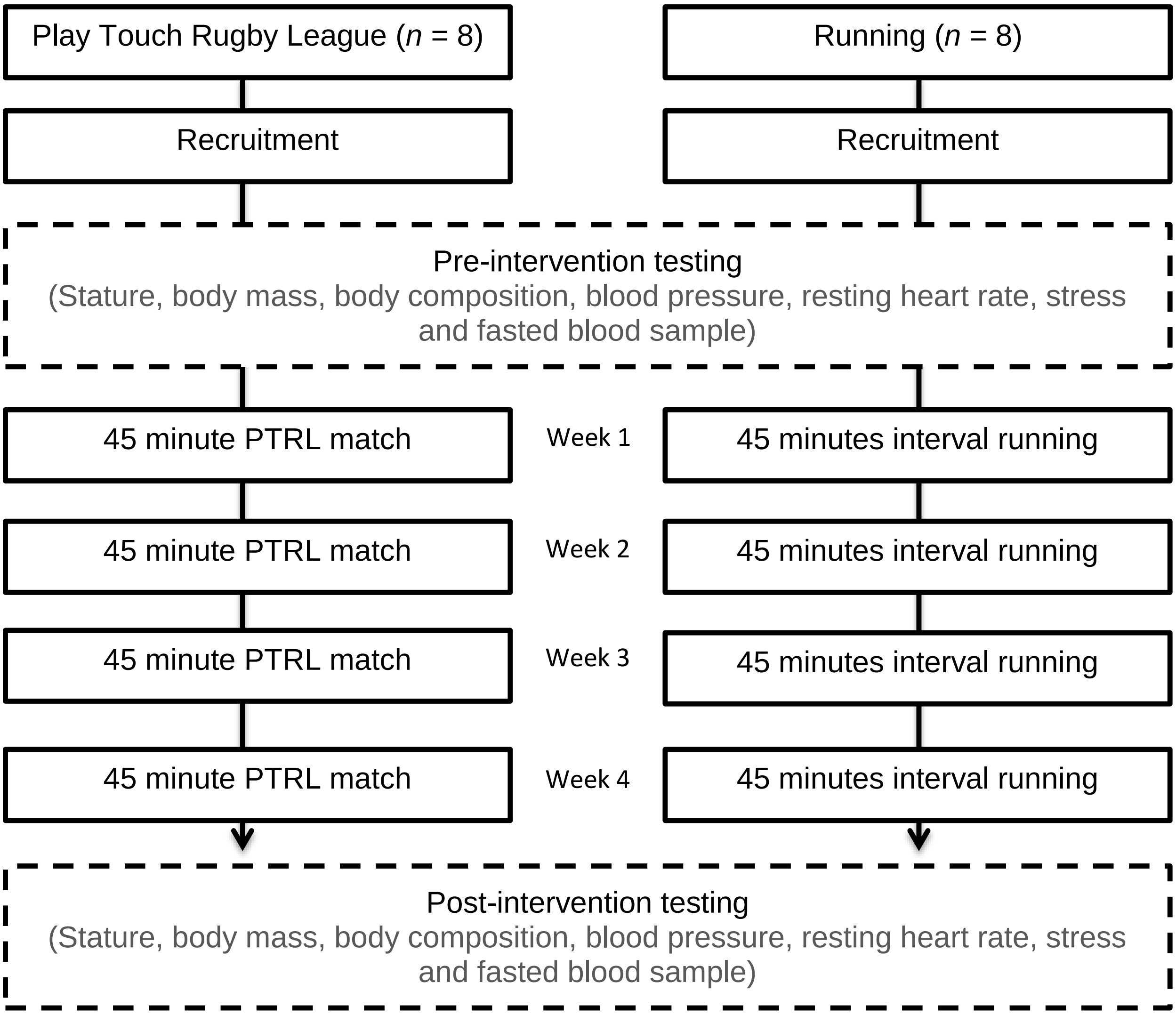

Figure 1. Schematic overview of study design, participant numbers, pre-intervention and post-intervention testing.

2.3. Measurements and protocols

2.3.1 Anthropometry and body composition

All testing procedures were conducted at a standardized time for each participant (0700 - 0900 hours) and by the same researcher throughout the study. Anthropometric measures included stature (Seca, Leicester Height Measure, Hamburg, United Kingdom), body mass (Seca, 813, Hamburg, Germany) and WC and HC from the midway between the lowest rib and the iliac crest and the widest part of the gluteal, respectively. All measures were subsequently used to calculate BMI ($BMI = \frac{Body\ mass\ (kg)}{Stature\ (m^2)}$) and WHR. %BF, FM and FFM were measured by bioelectrical impedance (BIA) using a tetra-polar device (Bodystat, 1500, Bodystat, Douglas, Isle of Man). This method is based upon resistive impedance and the principle that electrical conductivity of FFM is greater than that of FM (Bahadori et al., 2006). BIA required the participants to be euhydrated and rested in a supine position. Two injector electrodes were then placed on the right hand and foot proximal to metacarpal-phalangeal and metatarsal-phalangeal joints and two detector electrodes between the radius and ulna and the medial and lateral malleoli, respectively. This method has been reported to have excellent reliability coefficients (r = 0.994) and test-retest reliability (Fornetti, Pivarnik, Foley & Fiechtner, 1999; Kilduff, Lewis, Kingsley & Dietziz, 2007).

2.3.2. Blood pressure and resting heart rate

Resting blood pressure was measured before and after the 4-week intervention, with participants rested in a seated position for a minimum of 10 minutes before each measurement. Blood pressure was measured manually using an aneroid sphygmomanometer (WelchAllyn, Durashock Handheld Aneroid, Cachan, France) and stethoscope (Littmann, Select, 3M Health Care, Neuss, Germany), with the average of three measurement used for analysis. RHR was measured with participants in a seated position using a heart rate monitor (Polar Electro, FS1, Polar Electro, Oy Finland), with the lowest average value obtained during a 1-minute period used for analysis (Schmidt et al. 2013).

2.3.3. Blood analyses

Blood samples were taken in the morning (0700 - 0900 hours) after a 12-hour overnight fast and having consumed no alcohol in the previous 24 hours. After 20 minutes of rest, a 10 mL sample was obtained from the median cubital vein and placed into vacutainers (BD) containing di-potassium ethylene diamine tetra-aceticacid. Full blood count analysis was performed using a Coulter® Mixrodiff18 automated cell counter (Beckman Coulter, UK) within 24 hours of collection (refrigerated at 4°C). Whole blood was then centrifuged at 3000 rpm for 10 minutes and plasma stored at -30ºC. Plasma was analysed in duplicate to determine concentrations of circulating CRP and serum IL-6 using an enzyme-linked immunosorbent assay (ELISA; Quantikine High Sensitivity, R&D Systems, Minneapolis, USA). The optical density for CRP and IL-6 were measured using a microplate reader (Biochrom EZ Read 400, Biochrom, Cambridge, UK) at a wave length on 570 nm and 450, respectively. CRP and IL-6 were measured with an inter- and intra-coefficient of variation of between 3.8% to 7.0% and 1.6% to 3.4%, respectively.

2.3.4. Perceived stress

Perceived stress was assessed before and after the intervention using the Perceived Stress Scale-10 (Appendix 6; Cohen, Kamarack, & Mermelstein, 1983). Each question is rated on a 5-point Likert scale ranging from ‘never’ (0) to ‘almost always’ (4). Scores were obtained by reversing the scores on the four positive items and then summing across all 10 items.

2.4. Physical activity and training interventions

2.4.1. Nutrition and physical activity standardizations

All participants were encouraged to maintain their normal dietary intake throughout the duration of the study. Furthermore, participants were asked to maintain their habitual physical activity, but to record the frequency, duration and perceived intensity at the end of each week using a non-validated questionnaire (Appendix 9).

2.4.2. Play Touch Rugby League (PTRL) intervention

All PTRL sessions required participants to complete 45 minutes (2 x 20 minute halves) of six-a-side touch rugby on a natural grass (width: 40 m; length 60 m) pitch. The game required each team to complete six 'plays' whilst in possession of the ball and pass the ball backwards to an onside player once they had been 'touched' by the defending team. After a successful touch, play would resume with a 'play of the ball' whereby the attacking team would play the ball backwards through their legs and move forwards, whilst the defending team retreated 5 m. After a successful try or six unsuccessful attempts, play would be lost to the defending team (Kennet, Kemptom & Coutts, 2012).

Fifteen minutes before each session a 10 Hz global positioning system (GPS; Catapult, OptimEye S5, Catapult Innovations, Scoresby, Australia) was activated and positioned in a custom-made harness with the GPS positioned between the scapulae. The average number of satellites was 15.2 ± 3.8 for all sessions, which is considered optimal for human movement (Jennings, Cormack, Coutts, Boyd, & Aughey, 2010) and to exclude any possible intra-model variability, participants wore the same unit for all sessions (Randers Nielsen, Bangsbo & Krustrup, 2014). The

10Hz system has recently been reported as reliable and valid for measuring the movement patterns during intermittent exercise (Akenhead, French, Thompson & Hayes, 2014). For example, Castellano, Casamichana, Calleja-Gonzalez, Roman, & Ostojic, (2011) reported a coefficient of variation of 1.3% and 0.7% for sprints over 15 m and 30 m, respectively. Players also wore a heart rate monitor (Polar Electro, Finland, Oy), which was positioned directly on the skin. Mean and peak heart rates were recorded on each GPS device. Data was analysed (Catapult Sprint version 5.1.4), using the following movement bands: low intensity (< 9.0 $km{\cdot}h^{-1}$), moderate intensity (9.1-13.0 $km{\cdot}h^{-1}$) and high intensity (> 13.1 $km{\cdot}h^{-1}$; Randers et al., 2014).

Immediately after the session, participants were required to complete the Subjective Exercise Experience Scale (SEES), which was used to assess the participants sense of positive well-being, psychological distress and fatigue (Appendix 7; McAuley & Courneya, 1994). In addition, players individually provided a rating of perceived exertion using Borg's CR-10 scale (Borg, Ljunggren & Ceci, 1985) 10 minutes after each match, which was multiplied by their playing duration to provide sRPE (Foster et al., 2001).

2.4.3. Self-paced interval running intervention (RUN)

The running session was conducted on a natural grass surface and comprised of 45 minutes (2 x 20 minute halves) of self-paced running (RUN), whereby participants dictated their pace during each 20-minute half. Participants were required to wear a GPS and a heart rate monitor during each session. The same movement bands as described above were used for analyses and average number of satellites was 13.7 ± 3.3. To exclude any possible intra-model variability, participants wore the same GPS unit and heart rate monitor for all sessions

(Randers, Nielsen, Bangsbo & Krustrup, 2014). Immediately after each session, participants were required to complete the SEES scale (McAuley & Courneya, 1994), and after 10 minutes provided a rating of perceived exertion using Borg's CR-10 scale (Borg et al.,1985), which was multiplied by their playing duration to provide sRPE (Foster et al., 2001).

2.5. Statistical analysis

All data were log transformed to reduce bias due to non-uniformity of error and analysed using effect sizes (ES) with 90% confidence intervals (CI) and percentage (%) change. Magnitude-based inferences were calculated for each dependent variable based on the following 90% confidence limits: < 0.5% most unlikely, 0.5-5% very unlikely, 5-25% unlikely, 25-75% possibly, 75-95% likely, 95-99.5 very likely, > 99.5 most likely (Batterham & Hopkins, 2006). Magnitude of the observed changes was assessed using the following thresholds: trivial < 0.2, small 0.2 - 0.6, moderate 0.6 - 1.2, large 1.2 - 2.0, and very large > 2.0 (Hopkins, 2009). All calculations were completed using a predesigned spreadsheet (Hopkins, 2006).

3.0. Results

3.1. Baseline physical activity

Differences between the PTRL and RUN for previous (6 months) physical activity frequency and duration group were *unclear* (-9.5%, -0.47 ± 0.71; and -8.8%, -0.53 ± 1.02, respectively). Similarly, during the 4-week intervention, between group differences in weekly physical activity frequency, duration and perceived intensity were also *unclear* (-5.3%, -0.30 ± 0.69; -7.5%, -0.30 ± 0.52; and -4.0%,-0.19 ± 0.74).

3.2. Health markers

3.2.1. Anthropometry

Differences in baseline measures of age (0.5%, 0.02 ± 0.73), stature (0.1%, 0.02 ± 0.69) and body mass (0.7%, 0.04 ± 0.67) were *unclear* between the PTRL and RUN group. Further, differences in baseline BMI (-0.1%, -0.01 ± 0.67), WC (5.4%, 0.44 ± 0.68) and HC (-0.2%, -0.03 ± 0.63) were also *unclear* when compared between groups. In contrast, WHR was *likely* lower in the PTRL group compared to the RUN group (6.0%, 0.88 ± 0.82). When compared to baseline, body mass was *most likely* higher and *very likely* lower after the PTRL (0.5%, 0.03 ± 0.08) and RUN (-0.2%, 0.02 ± 0.14) interventions, respectively. Compared to baseline, BMI (0.2%, 0.01 ± 0.08) and HC (1.3%, 0.11 ± 0.26) were *likely* higher, WC (0.4%, 0.05 ± 0.15) was *possibly higher* and WHR (1.2%, 0.18 ± 0.46) was *unclear* after the PTRL intervention. In contrast, WC (-1.2%, -0.15 ± 0.22) and HC (-0.9%, -0.27 ± 0.23) were *possibly* lower compared to baseline after the RUN intervention and changes in BMI (-19.0%, -0.17 ± 0.45) and WHR (-0.8%, -0.11 ± 0.21) were *unclear.*

3.2.2. Body composition

Between group differences in FM (-12.4%, -0.46 ± 0.83) and FFM (3.2%, 0.2 ± 0.66) were *unclear at baseline*, whilst %BF (-12.7%, -0.95 ± 1.1) was *likely* higher in the PTRL group compared to the RUN group. Compared to baseline, FM (19.9%, -0.78 ± 0.35) and %BF (-16.9%, -1.30 ± 0.55) were *very likely* and *most likely* lower after the PTRL intervention. Fat mass (-2.6%, -0.08 ± 0.17) was *likely* lower but changes in %BF (-0.8%, -0.03 ± 0.25) were *unclear* when compared to baseline for the RUN group. FFM was *likely higher* after the PTRL intervention (2.8%, 0.18 ± 0.22) and *likely* lower after the RUN intervention (-1.1, -0.12 ± 0.17).

3.2.3 Resting heart rate and blood pressure

Baseline RHR and SBP were *likely* higher in the PTRL group (-7.0%, -0.48 ± 0.67) compared to the RUN group (-8.5%, -0.79 ± 0.63) but differences in DBP were *unclear* (-1.2%, -0.10 ± 0.66). Compared to baseline, RHR was *likely* lower after both the PTRL and RUN interventions (-6.1%, -0.41 ± 0.37; and -4.6%, -0.48 ± 0.41, respectively). Similarly, SBP was *likely* lower after both the PTRL and RUN interventions (-5.1%, -0.47 ± 0.51; and -3.1%, -0.63 ± 0.59, respectively). There was an *unclear* change in DBP for both PTRL (4.6%, 0.35 ± 0.58) and RUN (0.3%, 0.04 ± 0.69) groups after the intervention period.

3.3.6 Perceived stress

At baseline, differences is perceived stress between the PTRL and RUN groups were *unclear* (-22.6%, -0.37 ± 0.72). Compared to baseline, changes in perceived stress over the 4-week training intervention were *unclear* for both the PTRL (-6.0%, -0.09 ± 0.39) and RUN groups (-3.3%, -0.06 ± 0.57).

Table 1. Changes in markers of health from pre- to post-intervention for the PTRL and RUN groups.

	PTRL		RUN	
	Pre	**Post**	**Pre**	**Post**
Body mass (kg)	83.5 ± 11.9	83.8 ± 11.8	83.6 ± 8.3	83.3 ± 6.8
Body mass index (kg·m^2)	26.2 ± 4.0	23.7 ± 10.0	26.0 ± 2.4	25.6 ± 2.9
Waist Circumference (cm)	85.1 ± 8.9	86.2 ± 8.0	89.5 ± 6.3	88.3 ± 4.8
Hip Circumference (cm)	102.3 ± 6.7	102.6 ± 5.8	101.9 ± 3.0	100.9 ± 2.0
Waist to Hip Ratio	0.83 ± 0.1	0.80 ± 0.1	0.88 ± 0.1	0.87 ± 0.1
Fat Mass (kg)	16.1 ± 3.9	14.0 ± 5.9	14.2 ± 3.4	13.8 ± 3.2
Fat Free Mass (kg)	67.4 ± 8.6	68.6 ± 8.3	69.3 ± 5.9	68.5 ± 4.9
Body fat percentage (%)	19.1 ± 2.5	16.8 ± 4.8	16.8 ± 3.0	16.7 ± 3.0
Resting Heart Rate (b·min^{-1})	65.9 ± 8.7	62.3 ± 10.9	61.0 ± 5.6	58.3 ± 5.9
Systolic Blood Pressure (mmHg)	134.0 ± 13.1	126.8 ± 6.1	122.3 ± 5.5	118.4 ± 4.2
Diastolic Blood Pressure (mmHg)	78.8 ± 8.9	82.0 ± 4.4	77.5 ± 5.2	77.8 ± 5.2
Stress (AU)	13.5 ± 6.0	11.8 ± 3.8	10.1 ± 4.3	9.6 ± 3.7

Data presented mean ± SD.

3.3.5 Blood analyses

Differences in baseline lymphocyte count (10.0%, 0.35 ± 0.73), granulocyte count (12.9%, 0.40 ± 0.92), CRP concentration (-43.1%, -0.88 ± 1.26) and IL-6 concentrations (48.5%, 0.29 ± 0.90) were *unclear* when compared between groups. In contrast, baseline WBC (-19.2%, -0.68 ± 0.73) and platelet counts (-178.3%, -1.41 ± 0.74) were *likely and very likely* lower in the PTRL group compared to the RUN group. Compared to baseline, changes in WBC (12.3%, 0.45 ± 0.80), granulocyte count (53.0%, 0.58 ± 1.18), platelet count (2.5%, 0.09 ± 0.34) and CRP concentration (43.1%, -0.88 ± 1.26) were *unclear* after the PTRL intervention. Lymphocyte count (18.9%, 0.64 ± 0.51) was *likely higher* and IL-6 concentration (-89.2%, -0.97 ± 0.63) was *very likely* lower after the PTRL intervention. Compared to baseline, changes in lymphocyte count (4.5%, 0.19 ± 0.59), platelet count (-1.9%, -0.08 ± 0.38), CRP concentration (-2.7%, -0.02 ± 0.75) and IL-6 concentration (-23.5%, -0.35 ± 7.66) were *unclear* after the RUN intervention. However, WBC (12.0%, -0.59 ± 0.70) and granulocyte count (-25%, -0.73 ± 0.77) were *likely* lower after the RUN intervention.

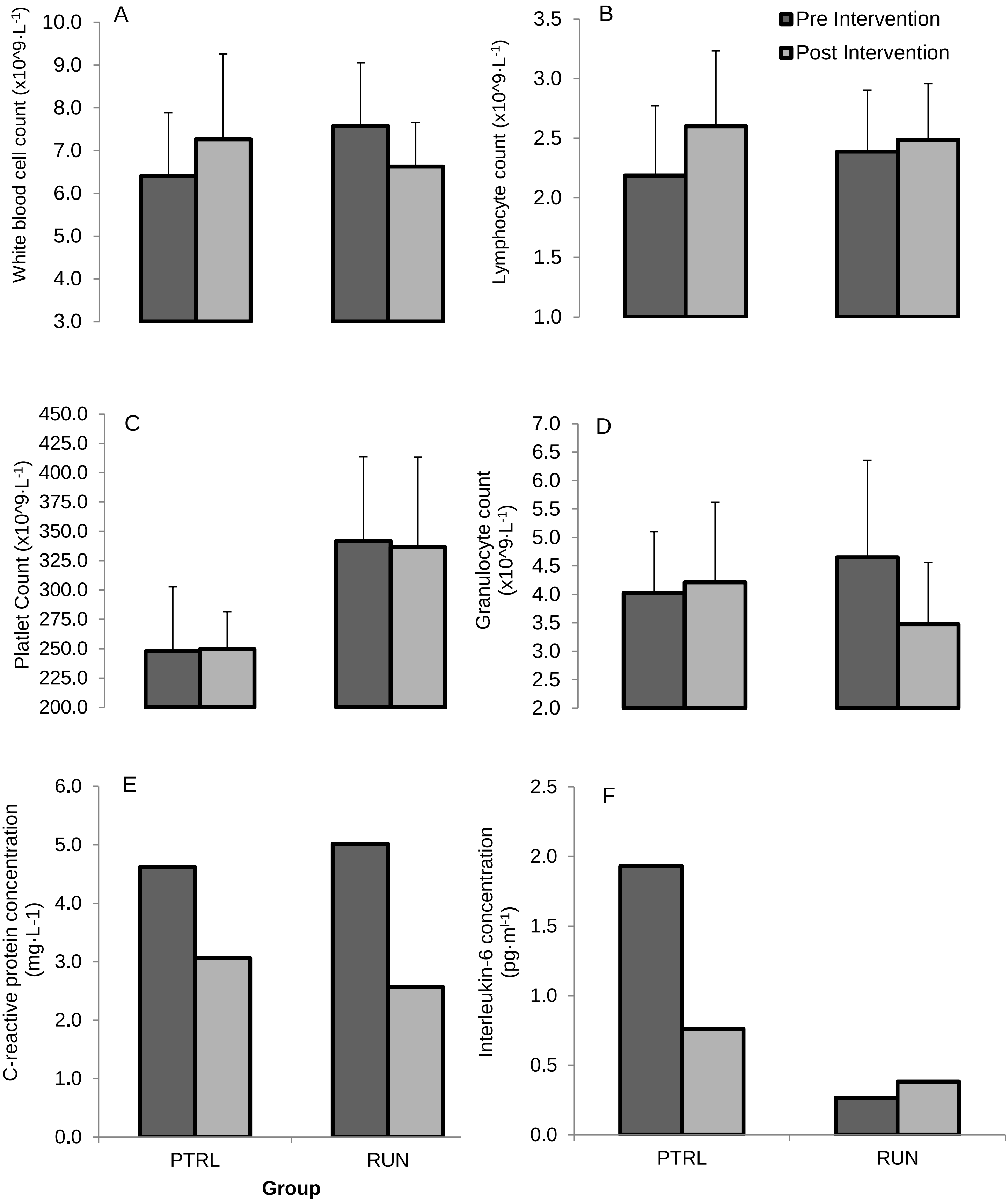

Figure. 2 Fasting blood chemistry of inflammatory cytokines, white blood cell count (A), lymphocyte count (B), platelet count (C), granulocyte count (D), C-reactive protein (E) and interleaukin-6 (F) before and after 4-weeks of PTRL and RUN.

3.3. External and internal responses to the PTRL and RUN interventions

3.3.1. External responses

Total distance covered during each session was *most likely* lower during the PTRL intervention compared to the RUN intervention (-133.9%, -4.57 ± 0.47). Similarly, distance covered at low intensity (< 9.0 km·h^{-1}; 45.4%, -1.49 ± 0.76) and moderate intensity (9.1 – 13.0 km·h^{-1}; -200.0%, -3.45 ± 1.25) were *most likely* lower during the PTRL intervention compared to the RUN intervention. In contrast, distance covered at high intensity (> 13.0 km·h^{-1}) was *most likely* higher during the PTRL intervention compared to the RUN (81.5%, 6.50 ± 2.62). Average velocity was *most likely* lower (-117.0%, -4.24 ± 0.48) and peak velocity was *most likely* higher (42.3%, 3.19 ± 0.52), during the PTRL intervention compared to the RUN intervention.

3.3.2. Internal responses

Mean heart rate was *very likely* higher during the RUN intervention compared to the PTRL (7.7%, 0.68 ± 0.42). When compared between groups, differences in peak heart rate was *unclear* (0.4%, 0.05 ± 0.50). Energy expenditure was most *likely* lower during the PTRL intervention (-97.5%, -3.82 ± 0.65).

Table 2. External and internal responses to the PTRL and RUN interventions.

Variable	PTRL	RUN
Distance (m)	3022.6 ± 622.3	6361.9 ± 891.5
Low intensity distance (m)	1816.5 ± 415.7	2982.6 ± 1543.8
Moderate intensity distance (m)	744.6 ± 207.6	3260.7 ± 1886.4
High intensity distance (m)	428.2 ± 121.0	84.8 ± 143.3
Average velocity ($km \cdot h^{-1}$)	8.48 ± 1.2	4.2 ± 0.8
Peak velocity ($km \cdot h^{-1}$)	13.8 ± 1.9	25.1 ± 3.8
Mean heart rate ($b \cdot min^{-1}$)	150.3 ± 16.5	162.0 ± 11.9
Peak heart rate ($b \cdot min^{-1}$)	193.9 ± 18.4	191.8 ± 13.3
Energy (Kj)	14.3 ± 3.0	26.5 ± 5.7
sRPE (AU)	166.3 ± 77.9	239.1 ± 81.2
Positive well-being (AU)	22.0 ± 4.2	20.4 ± 4.4
Psychological distress (AU)	6.5 ± 3.6	7.1 ± 3.5
Fatigue (AU)	11.3 ± 4.8	13.6 ± 5.2

Data presented and mean ± SD

3.3.3. sRPE and subjective exercise experience scale

Compared to the RUN intervention, sRPE was *likely* lower during the PTRL intervention (-17.9%, -0.55 ± 0.48). Differences in positive well-being (6.4%, 0.30 ± 0.59), psychological distress (-18.0%, -0.33 ± 0.55) and fatigue (-13.5%, 0.24 ± 0.60) were *unclear* when compared between groups.

4.0 Discussion

The aim of this study was to examine the efficacy of a 4-week PTRL and RUN intervention as an initiative to improve the health of habitually active men. The main findings were 4-weeks of PTRL and RUN was effective in lowering FM, RHR and

SBP but the PTRL intervention appeared more effective in lowering %BF and increasing FFM. In contrast, the RUN intervention appeared more effective in lowering WC, HC and WHR compared to the PTRL intervention. Changes in markers of inflammation appeared inconclusive when compared to baseline after both interventions, although the PTRL intervention did elicit a large reduction in IL-6 concentration. The results suggest that the high average and near-maximal heart rates experienced during both interventions were effective for promoting cardiovascular adaptations after only 4-weeks. The results also indicated that the high mechanical loading experienced during the PTRL intervention was important for reducing %BF, FM and increasing FFM.

Previous research has reported that elevated FM and %BF increases the risk of developing non-communicable diseases such as CVD (Maessen et al., 2014) and metabolic disease (Mendham, Duffield, Marino & Coutts, 2014b). The present study demonstrated that both interventions were effective at reducing FM after only 4-weeks of training (-2.6 kg and -0.4 kg). This finding is consistent with previous literature that has reported similar reductions after 12-weeks of soccer-specific SSGs (-2.7 kg), steady-state running (-1.8 kg), and 8-weeks of rugby-specific SSGs (-0.7 kg) and cycling (-0.8 kg; Krustrup et al., 2009; Mendham et al., 2015). However, it is important to note that PTRL appeared to elicit a more pronounced reduction in FM compared to the RUN intervention. This was similar for %BF, with a reduction of 2.3% and 0.1% in the PTRL and RUN groups, respectively. It has been suggested that SSGs elicit a high energy expenditure, which might increase fat oxidation, contributing to the more pronounced reductions in FM and %BF (Krustrup et al., 2013). However, using the GPS-derived metabolic calculations, the results indicate that more energy was expended during the RUN sessions (26.5 $Kj{\cdot}kg^{-1}$ vs. 14.3

Kj·kg^{-1}). It is reasonable to suggest that energy expenditure was under-estimated in the PTRL group since the GPS-derived calculations are based on changes in speed. Therefore, during interchanges when players are typically stationary no metabolic activity was recorded, despite the players still expending large amounts of energy (Buchheit, Manouvrier, Cassiram & Morin, 2015). Also, baseline %BF was higher in the PTRL group compared to the RUN, which could have influenced the magnitude of change between groups. Further, although there were no clear differences in weekly physical activity frequency, duration and perceived intensity, the amount of energy expended during these was unknown.

In contrast to the RUN group, the PTRL group increased FFM after only 4-weeks of training. The magnitude of change in the PTRL group (1.2kg) was similar to that reported after 8-weeks of rugby-specific SSGs (1.1 kg; Mendham et al., 2014b) and 12-weeks of soccer-specific SSGs (1.7 kg; Krustrup et al., 2009). In contrast, FFM was lower (-0.8 kg) in the RUN group. Previous research has reported no change in FFM after 12-weeks of running (Krustrup et al., 2009), which has been attributed to the lack of change in muscle fibre area and quadriceps muscle mass (Krustrup et al., 2010b). Therefore, the present study suggests high intensity distance and a higher maximal velocity could be important for promoting FFM (Krustrup et al., 2009; Helge et al., 2014; Krustrup et al., 2010b). More distance covered at high intensity and a higher maximal velocity is indicative of a large number of forceful accelerations and decelerations, which might be important to elicit sufficient stimuli to activate intracellular signalling for myofibrillar protein synthesis (Krustrup et al., 2010b) and an osteogenic response (Helge et al., 2014).

Following 4-weeks of PTRL, participants showed an increase in BMI, WC, HC and WHR. This finding is in contrast to the current literature, which has reported reductions in WC, WHR and BMI after 12-weeks of soccer training in habitually active men and inactive men (Knoepfli-Lenzin et al., 2010; Krustrup et al., 2009). There was an unclear change in BMI, but a reduction in WC, HC and WHR after 4-weeks of RUN, which is in agreement with the current literature. For example, it was reported that after 12-weeks of steady-state running, WC, HC, WHR and BMI were lower compared to baseline (Knoepfli-Lenzin et al., 2010; Krustrup et al., 2009). Is it possible that BMI was higher after the PTRL intervention due to the large increase in FFM, thus increasing total body mass. Changes in WC, HC and WHR after both interventions might have been influenced by diet. Although food diaries were used, participants were only required to complete these 48 hours prior to each blood sample and therefore their nutrient intake during the intervention was unknown.

The reductions in SBP after 4-weeks of PTRL and RUN (-7.3 mmHg and -3.9 mmHg), were thought to be of sufficient magnitude to be clinically meaningful (Pedersen & Saltin, 2006). The reductions in SBP were similar to that previously reported after 12-weeks of SSGs in untrained men (Krustrup et al., 2009) and 24-weeks of SSGS in diabetic men (Schmidt et al., 2013). At baseline, both groups reported a RHR which was indicative of being active. To date, this if the first study to conclude that 4-weeks of PTRL and RUN were effective at lowering RHR in active men. The magnitude of change after the PTRL (-3.6 b·min^{-1}) and RUN (-2.8 b·min^{-1}) interventions was similar to that previously reported in untrained men (Krustrup et al., 2009; Filliau et al., 2014; Schmidt et al., 2013) and premenopausal women (Krustrup et al., 2010). Several mechanisms have been proposed for lowering SBP and RHR, including a reduction in sympathetic outflow, vasoconstrictor state of the peripheral vasculature and vascular remodelling, which might include changes in the diameter and cross-sectional areas of existing veins and/or arteries (Krustrup et al., 2010b; Pescatello et al., 2004).

It is important to note that there were differences in SBP and RHR between groups prior to the intervention. Therefore, the greater reduction after the PTRL session might be a consequence of having a higher initial baseline SBP and RHR compared to the RUN group. In support, previous research has reported larger reductions in hypertensive populations (Andersen et al., 2010; Krustrup et al., 2013; Knoepfli-Lenzin et al., 2010) compared to normotensive populations (Filliau et al., 2015; Krustrup et al., 2009; Mendham et al., 2014a) after a period of SSGs. Although neither group were hypertensive, the higher baseline values might explain some of the difference observed between groups. Additionally, the PTRL group covered greater high intensity distance and peak speed, which may be indicative of high mechanical loading. These external demands may be effective for promoting muscle capillarization (expressed as number capillaries per fibre), which in part might, help explain the differences in blood pressure. Changes in DBP were unclear when compared to baseline after both interventions. This finding is in contrast to the current literature and might be due to the training status of the participants used. For example, several authors have reported a significantly lower DBP in untrained and/or diseased population after a period of SSGs (Krustrup et al., 2009; Andersen et al., 2010a; Krustrup et al., 2013; Mohr et al., 2014; Schmidt et al., 2014; Filliau et al., 2014).

Changes in white blood cell count, lymphocyte count, granulocyte count and platelet count were inconclusive after 4-weeks of PTRL and RUN, with any changes observed being negligible. Given that IL-6 concentration can stimulate hepatic synthesis of CRP, it was expected that an intervention that can lower IL-6 concentration would also lower CRP (Donges et al., 2013; Mendham et al., 2014a; Petersen & Pedersen, 2005). However, the present results indicate that the PTRL intervention was effective for lowering IL-6 concentrations but not CRP concentration. Similarly, Donges et al. (2013) reported a significant reduction in IL-6 concentration but no change in CRP concentration after 12-weeks of endurance, resistance and concurrent training in sedentary middle-aged men. It was postulated that the lower baseline CRP concentrations in the study by Donges et al. (2005) was a key factor as the participants were classified as having low (< 1 $mg \cdot L^{-1}$) to moderate (1-3 $mg \cdot L^{-1}$) concentrations of CRP (Lakka et al., 2005). However, using the same classifications provided by Lakka et al. (2005), the participants in the current study were classified as high (> 3 $mg \cdot L^{-1}$), yet no difference in CRP was observed.

The RUN group reported no differences in IL-6 or CRP concentrations after the intervention period. The between group differences in concentrations of IL-6 might, in some part, be linked to changes in FM, %BF and FFM. It was previously noted that the chronic inflammatory state is mediated by the ratio of FM and FFM (Mendham et al., 2014b). Therefore, the intermittent demands of PTRL might be more effective for promoting positive changes in body composition, which in turn could lower concentrations of IL-6 (Bastard et al., 2006). Overall, the present study indicates that changes in inflammatory markers were inconclusive after 4-weeks of PTRL and RUN. It is likely the small sample size, limited number of explored cytokines, training status and intervention period all limited the finding in the present study.

This is the first study to investigate the effectiveness of PTRL and RUN on perceived stress. There was no clear difference in baseline stress scores, but there was a small reduction in mean stress scores after the both the PTRL and RUN interventions (-1.7 AU and -0.5 AU, respectively). Therefore, further work is warranted to explore the usefulness of SSGs and running interventions to improve certain risk factors associated with mental health over a longer period of time.

It was hypothesised that the PTRL intervention would elicit feelings of positive well-being and lower feelings of psychological distress and fatigue. However the findings suggest that PTRL was no more effective than the RUN intervention for eliciting feelings of positive well-being and elicited comparable feelings of psychological distress and fatigue. However, over the 4-week intervention sRPE was higher in the RUN group compared to the PTRL group (239.1 AU vs. 166.3 AU, respectively). This suggests that although PTRL required more high intensity running, sprinting and sport-specific actions, the perception of effort was less than that experienced during the RUN intervention. This finding might have important implication when considering long-term adherence, as physical exertion has been suggested to be one of the greatest perceived ‘barriers’ to exercise (Lovell, Ansari & Parker, 2010).

5.0. Limitations

Despite the potential benefits of PTRL and RUN for promoting health, several limitations should be acknowledged. Firstly, the number of participants per group was relatively small, thus potentially limiting the validity of these findings. Further, there might have been changes that went undetected due to the large individual variation. Secondly, the use of bioelectrical impedance for determining changes in body composition might be viewed as a limitation as this method is sensitive to changes in hydration status, which was not measured during the present study. Additionally, changes in body composition may have been influenced by diet over the 4-week intervention and energy expenditure during habitual physical activity. Therefore, the use of food diaries and pedometers over the intervention period might have been useful to provide some insight into the daily activities during the intervention period. Finally, the present study only explored changes in two key pro-inflammatory cytokines in addition to, WBC and lymphocyte, granulocyte and platelet counts. It is acknowledged that the pro-inflammatory cascade is influenced by other cytokines for example tumour-necrosis factor-a and cytokines receptors, which were not measured in the present study, but might have played an important role.

6.0. Conclusion

The findings of the present study are in agreement with the literature, suggesting that participation in modified team sports such as PTRL is as, or more, effective than RUN for promoting positive changes in FM, FFM, %BF, SBP, RHR and potentially IL-6 concentration. Further, despite the PTRL group covering more high-intensity distance and achieving a higher peak velocity, sRPE was likely lower when compared to the RUN group. It is reasonable to suggest that interventions with low perceived exertion are more likely to be adhered to and therefore, PTRL might be a viable strategy for promoting health in sedentary, diseased and active populations. This is the first study to explore and compare the effects of a PTRL and RUN intervention over 4-weeks. The results indicate that participation over a 4-week period might be sufficient to promote health in active populations.

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Appendices

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Appendix 1. Health and previous physical activity questionnaire

(Please note that this information will be confidential)

Name………………………… DOB…………… Age……………....

Project Title: The role of 'Play Touch Rugby League' and self-paced interval running for improving men's health.

Please answer these questions truthfully and completely. The purpose of this questionnaire is to ensure that you are fit and healthy enough to participate in this laboratory practical/research project.

	Yes	No
1. Have you in the past suffered from a serious illness or accident. If Yes, please provide details.	☐	☐

………
……………………………………………

	Yes	No
2. Have you consulted your doctor the last 6 months If Yes, please provide details	☐	☐

………
………………………………………………

3. Do you suffer, or have you suffered from:

	Yes	No		Yes	No
Asthma	☐	☐	Rheumatoid Arthritis	☐	☐
Type 1 Diabetes	☐	☐	Angina	☐	☐
Bronchitis	☐	☐	Hyperlipidaemia	☐	☐
Type 2 Diabetes	☐	☐	Inflammatory bowel disease	☐	☐
High blood pressure	☐	☐	Crohn's Disease	☐	☐

	Yes	No
4. Is there any history of heart disease in your family	☐	☐

	Yes	No
5. Are you suffering from any infectious skin diseases, sores, wounds, or blood infections i.e., Hepatitis B, HIV, etc.? If Yes, please provide brief details.	☐	☐

………
……………………………………………

	Yes	No
6. Are you currently taking any medication If Yes, please provide details.	☐	☐

………
……………………………………………

	Yes	No
7. Are you suffering from a disease that inhibits the sweating process	☐	☐

	Yes	No
8. Is there anything to your knowledge that may prevent you from participating in the testing that has been outlined to you?	☐	☐

If Yes, please provide details.

………
…………………………………………………

Your Recent Condition

	Yes	No
• Have you eaten in the last 2 hours? If Yes, please provide details	☐	☐

………………………………………………………………………………………………

- Evaluate your diet over the last two days. **Poor** **Average** **Good** **Excellent**

	Yes	No
• Have you consumed alcohol in the last 24hr	☐	☐
• Have you had any kind of illness or infection in the last 2 weeks	☐	☐
• Have you exercised in the last 2 days?	☐	☐

If Yes, please describe below

………
………

Persons will not be permitted to take part in any experimental testing if they:-

- have a known history of medical disorders (i.e. hypertension, heart or lung disease)
- have a fever, suffer from fainting or dizzy spells
- are currently unable to train because of a joint or muscle injury
- have had any thermoregulatory disorder

- have gastrointestinal disorder
- have a history of infectious diseases (i.e. HIV or Hepatitis B)
- have, if pertinent to the study, a known history of rectal bleeding, anal fissures, haemorrhoids or any other similar rectal disorder.

My responses to the above questions are true to the best of my knowledge and I am assured that they will be held in the strictest confidence.

Name: (Participant)………………………………………………… Date:……………

Signed (Participant): …………………………………………………… ..

Name: (Lecturer/technician)………………………………… Date:………………

Signed (Lecturer/technician): …………………………………………..

Section B

The following sections will ask you about your weekly recreational physical activity over the last 6 months. The term "physical recreational activity' is defined as …

1. On average during the last 6 months, approximately how many times per week have you participated in physical recreational activity? *(please **only** tick one box)*

   Less than once per week ☐
   More than once per week ☐
   More than twice per week ☐
   More than four times per week ☐
   More than 5 times per week ☐

2. How long would you 'typically' participate in a physical recreational activity? *(please **only** tick one box)*

   Less than 30 minutes ☐
   More than 30 minutes per week ☐
   More than 45 minutes per week ☐
   More than 60 minutes per week ☐
   More than 90 minutes per week ☐
   More than 120 minutes ☐

3. During a typical week, which of following physical activities do you typically participate in and how many times per week? *(please tick **all** that apply)*

(Example: Walking ☑ 2 indicates walking, twice per week)

Gym (cardio)	☐	____	Gym (weights)	☐	____
Running / Jogging	☐	____	Floor exercises (e.g. stretching)	☐	____
Circuit training	☐	____	11-aside soccer	☐	____
Badminton	☐	____	7-aside soccer	☐	____
Boxing	☐	____	Rugby Union	☐	____
Squash	☐	____	5-aside soccer	☐	____
Rugby Union (small-sided)	☐	____	Rugby league (small-sided)	☐	____
Volleyball	☐	____	Rugby league	☐	____
Touch Rugby	☐	____	Boxercise	☐	____
Basketball	☐	____	Golf	☐	____
Wresting / Martial arts	☐	____	Other	☐	____

If other, please specify ……………………………………………

Appendix 2. Faculty of Life Sciences Ethical Approval letter

University of Chester

Faculty of Life Sciences

Research Ethics Committee

frec@chester.ac.uk

15/04/2015

Nicholas Dobbin
9 Eastway
Little Sutton
CH66 1SG

Dear Nicholas Dobbin

Study title: **The role of 'Play Touch Rugby League' and sef-paced interval running for improving men's health.**

FREC reference: **1010/15/ND/SES**

Version number: **1**

Thank you for sending your application to the Faculty of Life Sciences Research Ethics Committee for review.

I am pleased to confirm ethical approval for the above research, provided that you comply with the conditions set out in the attached document, and adhere to the processes described in your application form and supporting documentation.

The final list of documents reviewed and approved by the Committee is as follows:

Document	Version	Date
Application Form	1	February 2015
Appendix 1 – List of References	1	February 2015
Appendix 2 – Summary CV for Lead Researcher	1	February 2015
Appendix 3 – CV for additional researcher	1	February 2015
Appendix 4 – Letter(s) of invitation to participants	1	February 2015

Appendix 5 – Participant Information Sheet [PIS]	2	April 2015
Appendix 6 – Participant Consent Form	1	February 2015
Appendix 7 – Written permissions from relevant personnel.	1	February 2015
Appendix 8 – Validated questionnaire	1	February 2015
Appendix 9 – Non-validated questionnaire	2	April 2015
Appendix 10 – Risk Assessment	1	February 2015
Appendix 11 – Attendance certificate for phlebotomy training	1	February 2015
Appendix 12 – Diet Diary	1	April 2015
Response to FREC request for further information or clarification		
Appendix 13 – Additional PIS	1	April 2015

Please note that this approval is given in accordance with the requirements of English law only. For research taking place wholly or partly within other jurisdictions (including Wales, Scotland and Northern Ireland), you should seek further advice from the Committee Chair / Secretary or the Research and Knowledge Transfer Office and may need additional approval from the appropriate agencies in the country (or countries) in which the research will take place.

With the Committee's best wishes for the success of this project.

Yours sincerely,

Dr. Stephen Fallows

Chair, Faculty Research Ethics Committee

Enclosures: Standard conditions of approval.

Cc. Supervisor/FREC Representative

Appendix 3. Participation information sheet for Play Touch Rugby League

Participant Information Sheet – <u>Play Touch Rugby League</u>

The role of 'Play Touch Rugby League' and self-paced interval running for improving men's health

You are being invited to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask the research if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

Thank you for reading this.

What is the purpose of the study?

This research is being undertaken on healthy recreationally active males that do not currently meet the recommended guidelines for physical activity. The project's aim is to explore whether the addition of one extra recreational activity in the form of Play Touch Rugby League provides beneficial effects on physical and mental measures of health when compared to a group who perform more traditional exercise.

Why have I been chosen?

You have been chosen because you are male, aged between 25 and 50 years and have participated in recreational physical activity in the last 6 months but have not met the current physical activity recommendations. Additionally, you do not smoke or have any pre-existing metabolic or cardiovascular disorders and are currently taking no anti-inflammatory medication.

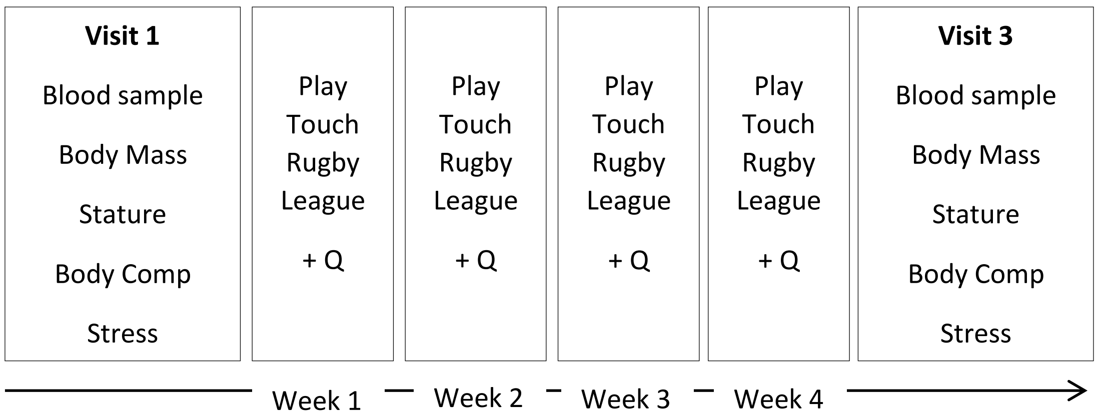
Do I have to take part?

It is up to you to decide whether or not to take part. If you decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect you in any way.

What will happen to me if I take part?

You will be required to complete a questionnaire detailing your previous recreational physical activity and current health status. Before the first measurements, you will be required to record your diet over two days, consume no alcohol 24 hours beforehand and complete a 12 hours fast. During the first visit, the researcher will arrange a time and location for collection of blood and measures of blood pressure, resting heart rate, body mass, waist and hip circumference and body fat and lean body mass as well as getting each participant to complete the Cohen's perceived stress scale. During the next four weeks, you will participate in your usual recreational physical activity plus one session of Play Touch Rugby League per week. You will also be asked to complete a brief questionnaire regarding your feeling immediately after each session of PTRL.

In addition, your weekly activity will be assessed through a questionnaire at the end of each week detailing the frequency, duration, perceived intensity. After two weeks, you will be required to provide another blood sample and measures of stress, blood pressure, resting heart rate, body mass, waist and hip circumference and fat and lean body mass. Finally, at the end of the study (4-weeks) you will be required to repeat measurements of each health marker and complete a short questionnaire regarding your perceived stress.



What are the possible disadvantages and risks of taking part?

The research will require your commitment and time as you will be required to attend for testing on three occasions. Each visit will last approximately 60-90 minutes. Additionally, you could be required to take part in one extra recreational physical activity session for a four-week period, lasting approximately 60 minutes. There is also a minimal risk of some discomfort from each blood sample.

What are the possible benefits of taking part?

By taking part, you will be contributing to the understanding of the role physical activity and the use of Play Touch Rugby League for promoting health. The researcher will provide you with all your data collected during the study in a written report.

What if something goes wrong?

If you wish to complain or have any concerns about any aspect of the way you have been approached or treated during the course of this study, please contact Professor Sarah Andrew, Dean of the Faculty of Life Sciences, University of Chester, Parkgate Road, Chester, CH1 4BJ, 01244 513055.

Will my taking part in the study be kept confidential?

All information, which is collected about you during the course of the research, will be kept strictly confidential so that only the researcher and supervisors carrying out the research will have access to such information.

What will happen to the results of the research study?

The results will be written up into a dissertation for my final project of my MRes and might be published. Individuals who participate will not be identified in any subsequent report or publication.

Who is organising or funding the research?

The research is conducted as part of an MRes in Sport and Exercise Science within the Department of Sport and Exercise Sciences at the University of Chester. The study is supervised and funded from the Department and the Rugby Football League.

Who may I contact for further information?

If you would like more information about the research before you decide whether or not you would be willing to take part, please contact:

Name: **Nick Dobbin**

Email: **n.dobbin@chester.ac.uk**

Phone: **01244 513465**

Thank you for your interest in this research.

Appendix 4. Participation information sheet for Running Group

Participant Information Sheet – <u>Control Group</u>

The role of 'Play Touch Rugby League' and self-paced interval running for improving men's health

You are being invited to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask the research if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

Thank you for reading this.

What is the purpose of the study?

This research is being undertaken on healthy recreationally active males that do not currently meet the recommended guidelines for physical activity. The project's aim is to explore whether the addition of one extra recreational activity in the form of Play Touch Rugby League provides beneficial effects on physical and mental measures of health when compared to a group who perform more traditional exercise.

Why have I been chosen?

You have been chosen because you are male, aged between 25 and 50 years and have participated in recreational physical activity in the last 6 months but have not met the current physical activity recommendations. Additionally, you do not smoke or have any pre-existing metabolic or cardiovascular disorders and are currently taking no anti-inflammatory medication.

Do I have to take part?

It is up to you to decide whether or not to take part. If you decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect you in any way.

What will happen to me if I take part?

You will be required to complete a questionnaire detailing your previous recreational physical activity and current health status. Before the first measurements, you will be required to record your diet over two days, consume no alcohol 24 hours beforehand and complete a 12 hours fast. During the first visit, the researcher will arrange a time and location for collection of blood and measures of blood pressure, resting heart rate, body mass, waist and hip circumference and body fat and lean body mass as well as getting each participant to complete the Cohen's perceived stress scale. During the next four weeks, you will participate in your usual recreational physical activity plus one session of traditional running exercise per week. You will also be asked to complete a brief questionnaire regarding your feeling immediately after each session of traditional running exercise.

In addition, your weekly activity will be assessed through a questionnaire at the end of each week detailing the frequency, duration, perceived intensity. After two weeks, you will be required to provide another blood sample and measures of stress, blood pressure, resting heart rate, body mass, waist and hip circumference and fat and lean body mass. Finally, at the end of the study (4-weeks) you will be required to repeat measurements of each health marker and complete a short questionnaire regarding your perceived stress.

Visit 1					**Visit 3**
Blood sample Body Mass Stature Body Comp Stress	Self-paced interval running + Q	Self-paced interval running + Q	Self-paced interval running + Q	Self-paced interval running + Q	Blood sample Body Mass Stature Body Comp Stress
	Week 1	Week 2	Week 3	Week 4	

What are the possible disadvantages and risks of taking part?

The research will require your commitment and time as you will be required to attend for testing on three occasions. Each visit will last approximately 60-90 minutes. Additionally, you could be required to take part in one extra recreational physical activity session for a four-week period, lasting approximately 60 minutes. There is also a minimal risk of some discomfort from each blood sample.

What are the possible benefits of taking part?

By taking part, you will be contributing to the understanding of the role physical activity and the use of Play Touch Rugby League for promoting health. The researcher will provide you with all your data collected during the study in a written report.

What if something goes wrong?

If you wish to complain or have any concerns about any aspect of the way you have been approached or treated during the course of this study, please contact Professor Sarah Andrew, Dean of the Faculty of Life Sciences, University of Chester, Parkgate Road, Chester, CH1 4BJ, 01244 513055.

Will my taking part in the study be kept confidential?

All information, which is collected about you during the course of the research, will be kept strictly confidential so that only the researcher and supervisors carrying out the research will have access to such information.

What will happen to the results of the research study?

The results will be written up into a dissertation for my final project of my MRes and might be published. Individuals who participate will not be identified in any subsequent report or publication.

Who is organising or funding the research?

The research is conducted as part of an MRes in Sport and Exercise Science within the Department of Sport and Exercise Sciences at the University of Chester. The study is supervised and funded from the Department and the Rugby Football League.

Who may I contact for further information?

If you would like more information about the research before you decide whether or not you would be willing to take part, please contact:

Name: **Nick Dobbin**

Email: **n.dobbin@chester.ac.uk**

Phone: **01244 513465**

Thank you for your interest in this research.

Appendix 5. Consent form

Title of Project: The role of 'Play Touch Rugby League' and self-paced interval running for improving men's health

Name of Researcher: Nicholas Dobbin

Please initial box

1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions.

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without my legal rights being affected.

3. I agree to take part in the above study.

Name of Participant	Date	Signature
Researcher	Date	Signature

Appendix 6. Cohens Perceived Stress Scale

The following questions ask about your feelings and thoughts during THE PAST MONTH. In each question, you will be asked HOW OFTEN you felt or thought a certain way. Although some of the questions are similar, there are small differences between them and you should treat each one as a separate question. The best approach is to answer fairly quickly. That is, don't try to count up the exact number of times you felt a particular way, but tell me the answer that in general seems the best.

For each statement, please tell me if you have had these thoughts or feelings: never, almost never, sometimes, fairly often, or very often. (Read all answer choices each time)

	Never	**Almost Never**	**Sometimes**	**Fairly Often**	**Very Often**
In the past month, how often have you been upset because of something that happened unexpectedly?					
In the past month, how often have you felt unable to control the important things in your life?					
In the past month, how often have you felt nervous or stressed?					
In the past month, how often have you felt confident about your ability to handle personal problems?					
In the past month, how often have you felt that things were going your way?					
In the past month, how often have you found that you could not cope with all the things you had to do?					
In the past month, how often have you been able to control irritations in your life?					
In the past month, how often have you felt that you were on top of things?					
In the past month, how often have you been angry because of things that happened that were outside of your control?					
In the past month, how often have you felt that difficulties were piling up so high that you could not overcome them?					

Appendix 7. Subjective Exercise Experience Scale

Subjective Exercise Experiences Scale

Instructions for Administering the Subjective Exercise Experiences Scale

By circling a number on the scale below each of the following items, please indicate the degree to which you are experiencing each feeling *now*, at this point in time, *after exercising*.

I feel:

1. Great

1	2	3	4	5	6	7
Not at all			Moderately			Very much so

2. Awful

1	2	3	4	5	6	7
Not at all			Moderately			Very much so

3. Drained

1	2	3	4	5	6	7
Not at all			Moderately			Very much so

4. Positive

1	2	3	4	5	6	7
Not at all			Moderately			Very much so

5. Crummy

1	2	3	4	5	6	7
Not at all			Moderately			Very much so

6. Exhausted

1	2	3	4	5	6	7
Not at all			Moderately			Very much so

7. Strong

1	2	3	4	5	6	7
Not at all			Moderately			Very much so

8. Discouraged

1	2	3	4	5	6	7
Not at all			Moderately			Very much so

9. Fatigued

1	2	3	4	5	6	7
Not at all			Moderately			Very much so

10. Terrific

1	2	3	4	5	6	7
Not at all			Moderately			Very much so

11. Miserable

1	2	3	4	5	6	7
Not at all			Moderately			Very much so

12. Tired

1	2	3	4	5	6	7
Not at all			Moderately			Very much so

Appendix 8. Example of food diary

Daily Food Diary

Name_______________________________

The following food diary should be completed on **2 days** prior to measures of health. This diary is designed to provide a comprehensive overview of your food and fluid intake. In completing this food diary, you should aim to adhere to the following guidelines, using the example below as a template:

- Record all food and fluid intake during the 2 days (**even water**), including the time of ingestion
- Provide information on how meals are prepared (i.e. fried, poached, grilled etc.)
- Include ingredients which are added to foods during cooking, such as olive oil, salt, butter etc.
- Provide the amount and type of food consumed in the most accurate way possible. Weighing your food is ideal, but if this isn't possible then include rough estimates on portion size (i.e. 1 cup full, teaspoon etc.)

Time	Food/Drink	Amount	Cooking Method
9 am	Quaker porridge oats with skimmed milk	50 g, ¼ pint	
	Muller fat-free Yogurt	1 average pot	
10 am	Bacon sandwich (wholemeal) & ketchup	2 rashers, 2 slices, tablespoon	Grilled

Day 1 (put date here)

Time	Food/Drink	Amount	Cooking Method

Day 2 (put date here)

Time	Food/Drink	Amount	Cooking Method

Appendix 9. Weekly physical activity questionnaire

1. On average during the last week (7 days), approximately how many times per week have you participated in physical recreational activity? *(please **only** tick 1 box)*

   - Less than once per week ☐
   - More than once per week ☐
   - More than three time per week ☐
   - More than 5 times per week ☐

2. How long did you 'typically' participate in a physical recreational activity? *(please tick **one** box)*

   - Less than 30 minutes ☐
   - More than 30 minutes ☐
   - More than 45 minutes ☐
   - More than 60 minutes ☐
   - More than 90 minutes ☐
   - More than 120 minutes ☐

3. During the last week how intense, did you feel the sessions were? *(Please tick **all** boxes that apply but indicate the number of session for each intensity)*

   - **Light** (i.e. walking slowly, cycling stationary, light stretching) ☐ ______
   - **Moderate** (i.e. walking briskly, cycling outdoors, swimming with moderate effort) ☐ ______
   - **High** (i.e. long distance running, cycling fast or racing, heavy resistance work) ☐ ______

Appendix 10. Example of data collection forms

Data Collection Sheet – Health markers – Visit 1

ID	RESTING HEART RATE (b·min-1)	BLOOD PRESSURE (mmHg)	WAIST CIR (cm)	HIP CIR (cm)	W:R	% BODY FAT (%)	BODY MASS (kg)	FAT MASS (kg)	FAT FREE MASS (kg
(A									
(B)									
(C)									
(D)									
(E)									
(F)									
(G)									
(H)									

Visit 1, 2, 3 & 4 GPS

Name	GPS Number	sRPE	Start Time	End 1st half	Start 2nd half	End Time
(A)	28100					
(B)	29099					
(C)	28063					
(D)	29087					
(E)	27815					
(F)	27882					
(G)	29008					
(H)	28115					